EV1™ 97-98

Propulsion System

Service Manual

CAUTION

To reduce the chance of personal injury and/or property damage, the following instructions must be carefully observed.

Proper service and repair are important to the safety of the service technician and the safe, reliable operation of all motor vehicles. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality.

The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specifically designed for the purpose.

Accordingly, anyone who intends to use a replacement part, service procedure, or tool that is not recommended by the vehicle manufacturer must first determine that neither his safety nor the safe operation of the vehicle will be jeopardized by the replacement part, service procedure, or tool selected.

It is important to note that this manual contains various "Cautions" and "Notices" that must be carefully observed in order to reduce the risk of personal injury during service or repair or the possibility that improper service or repair may damage the vehicle or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive; it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

This vehicle has a high voltage power system. Disabling the system is required when working on or around the high voltage system and high voltage battery pack (other than testing the system using the procedures in this manual).

To help avoid severe shocks and burns and vehicle damage, always follow the cautions in this manual to disable the high voltage system. See the high voltage disable and enable procedure in the front of this service manual.

This vehicle is equipped with Supplemental Inflatable Restraint (SIR). Refer to "CAUTIONS" under "On-Vehicle Service" and the SIR Component and Wiring Location views in the "SIR Service Manual" before performing service on or around SIR components or wiring. Failure to follow "CAUTIONS" could result in possible air bag deployment, personal injury, otherwise unneeded SIR system repairs.

To help avoid accidental air bag deployment and personal injury, when servicing a vehicle that requires repair of the SIR system and another vehicle system, it is recommended that the SIR be repaired first using service manual procedures.

CAUTION

Saturn Service Manuals are intended for use by professional, qualified technicians. Attempting repairs or service without the appropriate training, tools, and equipment could cause injury to you or others and damage to your vehicle that may cause it not to operate.

Table of Contents

PROPULSION

NOTICE

Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application.

The applicable service procedure will identify, where necessary, those fasteners that must be replaced after removal; or those fasteners that require thread lockers or thread sealant.

UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener.

When you install fasteners, use the correct tightening sequence and specifications.

Following these instructions can help you avoid damage to parts and systems.

DIAGNOSTIC TROUBLE CODE REFERENCE LIST

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DIAGNOSTIC TROUBLE CODE — **PG. #**

GLOSSARY OF ACRONYMS

Acronym	Definition
ABS	Anti-Lock Braking System
AM	Amplitude Modulation
Amp	Ampere
APM	Accessory AC and DC Power Control Module. With PIM, makes up PEB
APS	Auxiliary Power Supply (part of APM)
BCA	Bias Control Assembly
BPM	Battery Pack Module
BRS	Battery Reserve Switch
BTCM	Brake/Torque Control Module
BTSI	Brake Transmission Shift Interlock (GM)
CD	Compact Disc
cfm	Cubic Feet per Minute
cg	Center of Gravity
CHMSL	Center High-Mount Stop Lamp
CMC	Compressor Motor Controller (part of APM)
CPA	Connector – Positive Assurance
CR	Charge Receptacle
CRFM	Condenser Radiator Fan Module (part of HPVS)
CTPS	Check Tire Pressure System
DC	Direct Current
DLC	Data Link Connector
DERM	Diagnostic and Energy Reserve Module (SIR control module)
DIA	Dealer Installed Accessory
DM	Drive Motor
DRL	Daytime Running Light
E/M	English/Metric
ECM	Engine Control Module (used with internal combustion engines)
EHPS	Electro-Hydraulic Power Steering
EKP	External Keypad
EMB	Electro-Magnetic Brake (part of ABS)
EMI	Electromagnetic Interference
EPS	Electric Power Steering. Also see EHPS

GLOSSARY OF ACRONYMS CONTINUED

Acronym	Definition
ETS	Electronic Traction System
EV	Electric Vehicle
EVO	Electronic Variable Orifice Control (in power steering pump)
FLIP	Forward Lamp – Instrument Panel Harness. Name of major EV low voltage wire harness
FM	Frequency Modulation
FOD	Front of Dash
g	Gram
GFI	Ground Fault Interrupt
GVMR	Gross Vehicle Mass Rating
GVW	Gross Vehicle Weight
HPVM	Heat Pump Ventilation Module
HPVS	Heat Pump Ventilation System. Similar to HVAC on ICE vehicles
HTCM	HPVS/Thermal Control Module
HV	High Voltage
HVAC	Heating, Ventilating, and Air Conditioning (on ICE vehicles. For EV, see HPVS)
HWS	Heated Windshield
HWS	Hand Wheel Sensor
Hz	Hertz (cycles per second)
I/O	Input(s)/Output(s)
IC	Integrated Circuits
IGBT	Isolate Gate Bipolar Transistor
IP	Instrument Panel
ISRV	Inside Rear View (mirror)
JB	Junction Block
KAM	Keep Alive Memory
kg	Kilogram
km	Kilometer
km/h	Kilometers per hour

GLOSSARY OF ACRONYMS CONTINUED

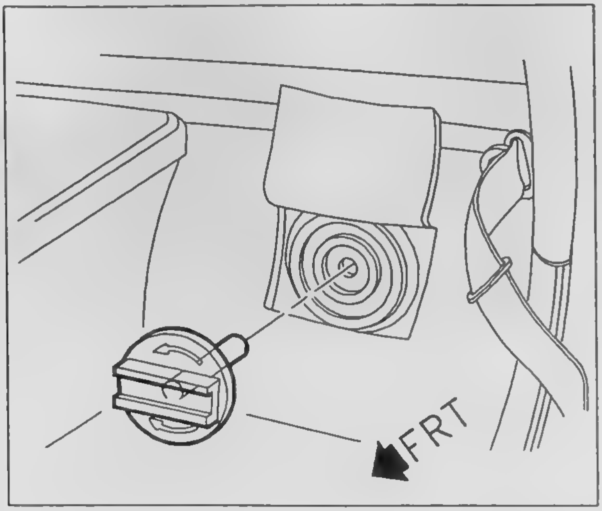
Acronym	Definition
kPa	Kilo Pascals
kW	Kilowatt
kWh	Kilowatt–hour
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LF	Left Front
LH	Left Hand
LHD	Left Hand Drive
LHJB	Left Hand Junction Block
LR	Left Rear
LVW	Loaded Vehicle Weight
m	Meter
MMC	Metal Matrix Composite (Rear Brake Drum Material)
MHz	Megahertz
mi	Mile(s)
MPH	Miles Per Hour
MSRP	Manufacturers Suggested Retail Price (includes dealer preparation)
MUX	Multiplex or Multiplexer
N	Newton(s)
NTF	No Trouble Found. Reported failure does not reoccur under test
OEM	Original Equipment Manufacturer
OSRV	Outside Rear View (mirror)
PCM	Propulsion Control Module (Drive Motor)
PDT	Portable Diagnostic Tool
PEB	Power Electronics Bay
PIM	Power Inverter Module
POA	Part of Assembly
PRND	Park–Reverse–Neutral–Drive, as in PRND Selector
PROM	Programmable Read Only Memory
PSOC	Pack State of Charge
PTC	Positive Thermal Coefficient. Term for resistive heating module
PWM	Pulse Width Modulation, or Pulse Width Modulated

GLOSSARY OF ACRONYMS CONTINUED

Acronym	Definition
QDM	Quad Driver Module
RAM	Random Access Memory
RAP	Retained Accessory Power
RF	Right Front
RF	Radio Frequency
RH	Right Hand
RH	Relative Humidity
RHJB	Right Hand Junction Block
RMS	Root-Mean-Squared
ROM	Read Only Memory
RP	Reduced Performance
RPM	Revolutions Per Minute
RR	Right Rear
RSA	Run/Lock Shifter Assembly
SAE	Society of Automotive Engineers
SDL	Serial Data Link
SDM	Sensor Diagnostic Module
SIR	Supplemental Inflatable Restraint (air bag) system
SLA	Short-Long Control Arm (suspension system)
SOC	State of Charge (battery pack). Usually expressed as a percentage
SN	Service Now
SSPO	Saturn Service Parts Operation
SS	Service Soon
SWA	Steering Wheel Angle
TNF	Trouble – Not Found. Reported failure reoccurs but cause cannot be determined
TJB	Trunk Junction Block
TOD	Time of Day
TPA	Terminal – Positive Assurance
T/S	Turn Signal
TT	Telltale

GLOSSARY OF ACRONYMS CONTINUED

Acronym	Definition
UART	Universal Asynchronous Receiver – Transmitter (communications IC)
UH	Under Hood
ULEV	Ultra-Low Emissions Vehicle
USOC	User State of Charge
V5B	5 Volt Supply
VAC	Voltage, Alternating Current
VF	Vacuum Fluorescence
VH	Vehicle Handling
VIN	Vehicle Identification Number
VTD	Vehicle Theft Deterrent
W	Watt
WSS	Wheel Speed Sensor (part of ABS)
WSW	Windshield Washer/Wiper
ZEV	Zero Emission Vehicle



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HIGH VOLTAGE DISABLE

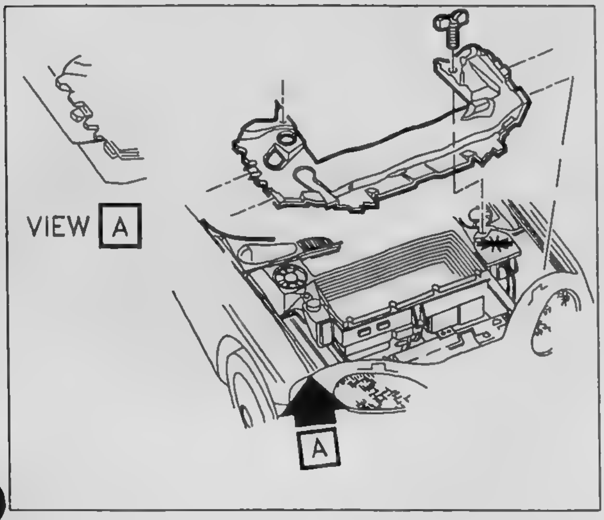
REMOVAL

CAUTION: TO REDUCE THE RISK OF SEVERE SHOCKS AND BURNS, THE HIGH VOLTAGE SYSTEM SHOULD BE DISABLED ANY TIME SERVICE WORK IS BEING PERFORMED ON OR AROUND THE HIGH VOLTAGE SYSTEM. WHEN IN DOUBT, ALWAYS DISABLE THE HIGH VOLTAGE SYSTEM. THE 12 VOLT SYSTEM WILL STILL BE ACTIVE AFTER THE HIGH VOLTAGE SYSTEM HAS BEEN DISABLED.

1. Place the vehicle in the "RUN" mode.
2. Remove the manual disconnect knob.
   a. Tilt the drivers seat forward.
   b. Raise the carpet flap, located on the battery tunnel behind the drivers seat.
   c. Turn the manual disconnect knob counterclockwise and pull the manual disconnect knob straight out.

IMPORTANT: An audible click should be heard when turning the manual disconnect knob. This click indicates the automatic disconnect relays have opened.

3. Verify high voltage has been removed.
   a. Connect scan tool to the data link connector (DLC) and run the High Voltage special test. Battery pack module (BPM) diagnostic trouble codes (DTCs) 312, 280 and/or 275 should be present, which indicates BPM and auto disconnect recognized a high voltage disconnect.
   b. If test fails, refer to "High Voltage Special Test Failed" in the "Battery and Charging System Service Manual."
4. Remove engine compartment sight shield.



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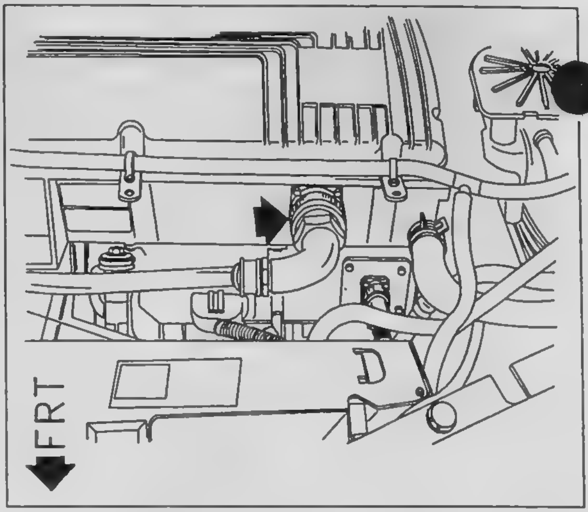
CAUTION: TO REDUCE THE RISK OF SEVERE SHOCKS AND BURNS, ALWAYS ASSUME THE HIGH VOLTAGE IS PRESENT WHEN DISCONNECTING THE CHARGE RECEPTACLE TO PIM CONNECTOR. DO NOT ALLOW THE CONNECTOR BODY TO TOUCH THE PINS OF THE PIM WHEN REMOVING THE CONNECTOR.

5. Remove the charge receptacle to power inverter module (PIM) cannon connector using one hand.



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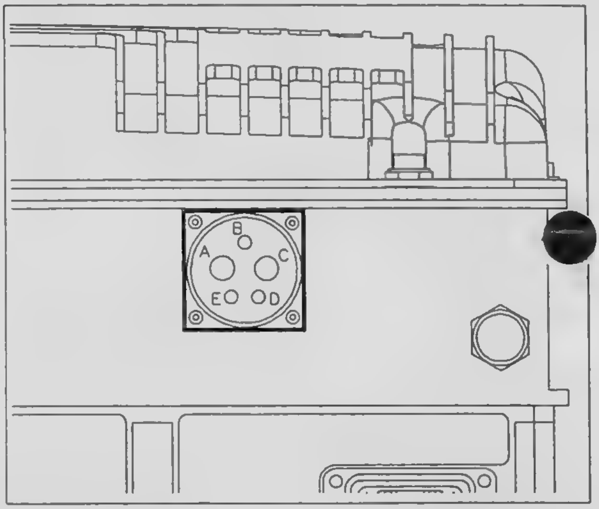
6. Using a DVOM and only one hand, measure from pin A of the PIM to chassis ground and from pin C of the PIM to chassis ground and from pin A to C. All measurements should be less than 10 volts. Pin C and Pin A are the large high voltage pins on the PIM.
   a. If the voltage is less than 10 volts, high voltage system is disabled.
   b. If the voltage is greater than 10 volts, refer to the "High Voltage" section in the "Battery and Charging Service Manual."



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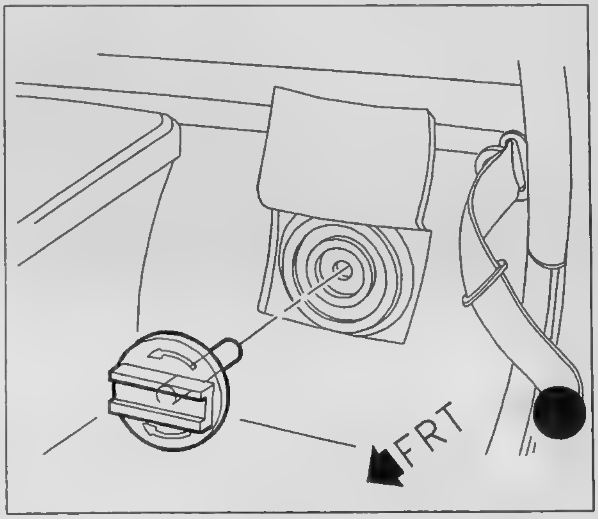
HIGH VOLTAGE ENABLE

INSTALLATION

1. Install charge receptacle to PIM cannon connector.
2. Install engine compartment sight shield.
3. Tilt driver's seat forward.
4. Raise the carpet flap, located on the battery tunnel behind the driver's seat.
5. Install the manual disconnect knob by pushing the shaft straight into the hole and turning clockwise.
6. Clear all DTCs using the scan tool.



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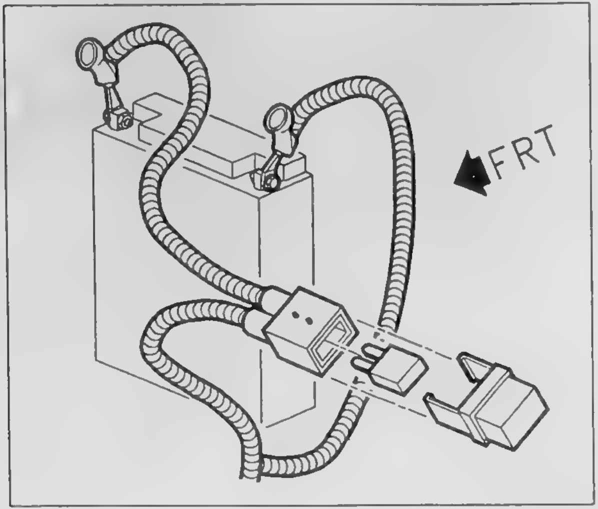

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12 VOLT SYSTEM DISABLE

CAUTION: DISABLE THE 12 VOLT ELECTRICAL SYSTEM TO HELP AVOID PERSONAL INJURY OR POSSIBLE DAMAGE.

IMPORTANT: The key pad must be in the LOCK mode for two minutes prior to performing the following step. Failure to do so could result in the loss of memory that retains the battery pack state of charge. If this occurs refer to "Battery Pack and Charging System" service manual for details.

1. Remove the cover on the 60 amp maxi fuse holder located in the negative auxiliary battery cable.
2. Remove the 60 amp maxi fuse.

12 VOLT SYSTEM ENABLE

1. Install 60 amp maxi fuse located on the negative auxiliary battery cable
2. Place cover on maxi fuse holder.

SIR SYSTEM

ON VEHICLE SERVICE

SERVICE PRECAUTIONS

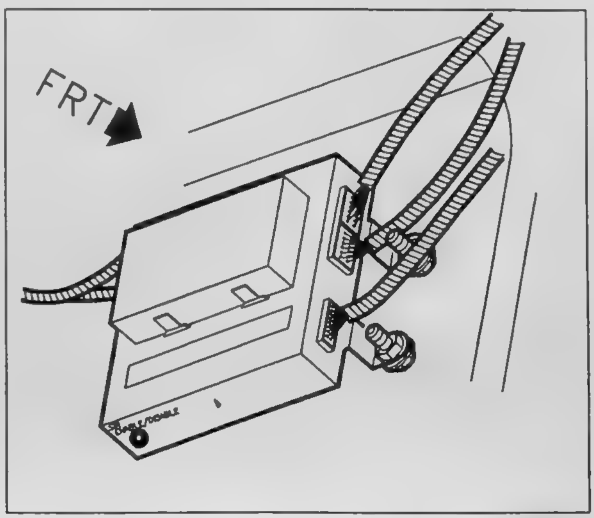
CAUTION: WHEN PERFORMING SERVICE ON OR AROUND SIR COMPONENTS OR SIR WIRING FOLLOW THE PROCEDURE BELOW TO TEMPORARILY DISABLE THE SIR SYSTEM. FAILURE TO FOLLOW PROCEDURES COULD RESULT IN POSSIBLE AIR BAG DEPLOYMENT, PERSONAL INJURY OR OTHERWISE UNNEEDED SIR SYSTEM REPAIRS.

THE SENSING AND DIAGNOSTIC MODULE (SDM) CAN MAINTAIN SUFFICIENT VOLTAGE TO CAUSE A DEPLOYMENT FOR UP TO *10 MINUTES* AFTER THE KEY PAD HAS BEEN PLACED IN THE "LOCK" MODE, ALSO IF THE AUXILIARY BATTERY IS DISCONNECTED OR THE SIR "ENABLE/DISABLE" SWITCH IS PLACED IN THE DISABLE POSITION. MANY OF THE SERVICE PROCEDURES REQUIRE THE SIR "ENABLE/DISABLE" SWITCH TO BE PLACED IN THE "DISABLE" POSITION AND DISCONNECTION OF THE DEPLOYMENT LOOPS TO AVOID AN ACCIDENTAL DEPLOYMENT.

DISABLING THE SIR SYSTEM

1. Turn the steering wheel so that the vehicle's wheels are pointing straight ahead.
2. Place the key pad in the **LOCK** mode.
3. Place the SIR **"ENABLE/DISABLE"** switch in the right hand junction block in the **DISABLE** position.

IMPORTANT: With the SIR **ENABLE/DISABLE** switch in the **DISABLE** position and the key pad in the RUN mode, the AIR BAG telltale lamp will be "On." This is normal operation and does not indicate a SIR system malfunction.



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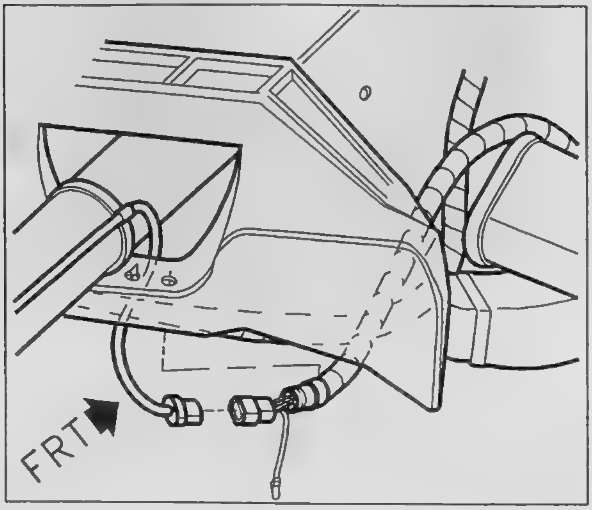

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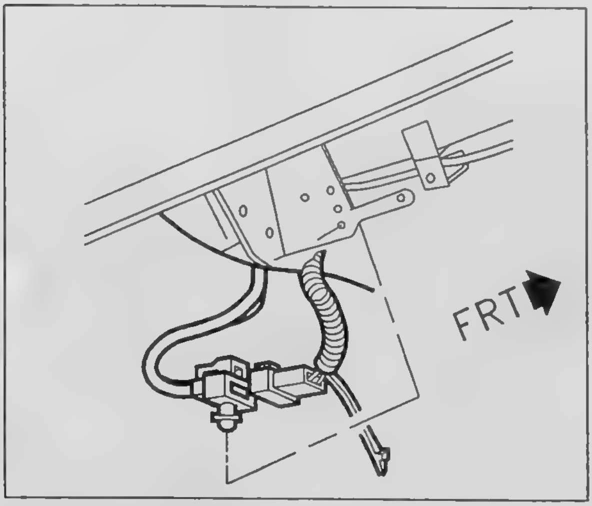
4. Remove connector position assurance (CPA) device and disconnect yellow two-way connector located near the base of the steering column.



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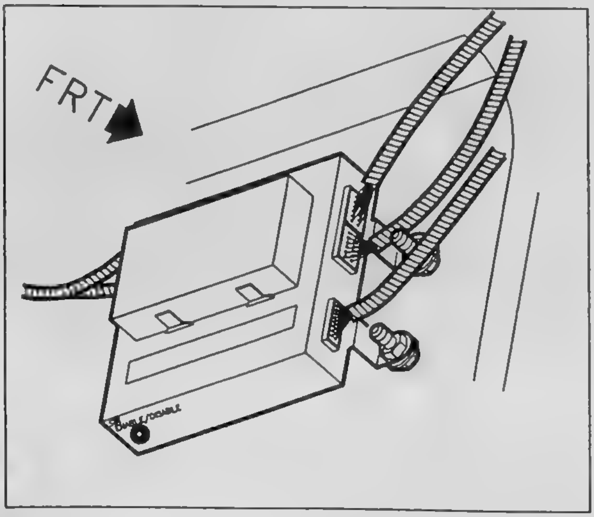
5. Remove connector position assurance (CPA) device and disconnect yellow two-way connector located on passenger inflator module pigtail under RH side of I/P.



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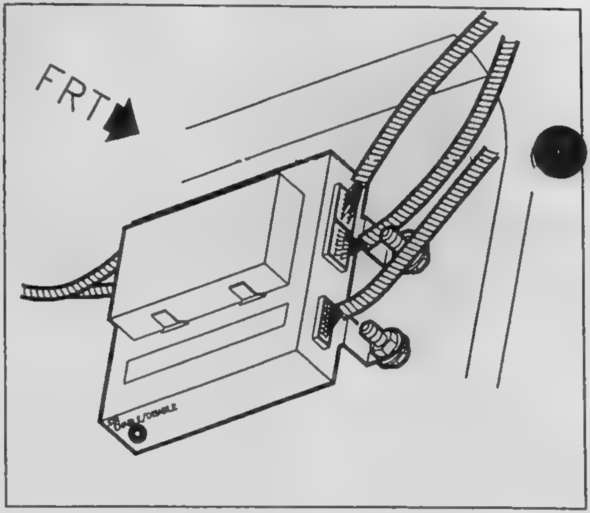
ENABLING THE SIR SYSTEM

1. Place key pad in the **LOCK** mode.
2. Connect yellow two-way SIR connector at the base of steering column and install connector position assurance (CPA) device to connector.
3. Connect yellow two-way passenger inflator module pigtail and install connector position assurance (CPA) to connector.
4. Place SIR **ENABLE/DISABLE** switch to the **ENABLE** position, located in the RH junction block.
5. Place key pad in the "RUN" mode and verify that the AIR BAG telltale lamp flashes seven times as the key pad is placed in the "RUN" mode and then goes Off. If lamp does not operate as described above perform the "SIR Diagnostic System Check" in this manual.

JUNCTION BLOCK GROUND STRAP INSTALLATION / REMOVAL PROCEDURE

NOTICE: If RH or LH junction block needs to be removed from mounting studs for diagnosis, tool EV9713Z must be used while vehicle is powered-up or electrical system damage may result. (Refer to "Junction Block Ground Strap Installation" in this manual.)



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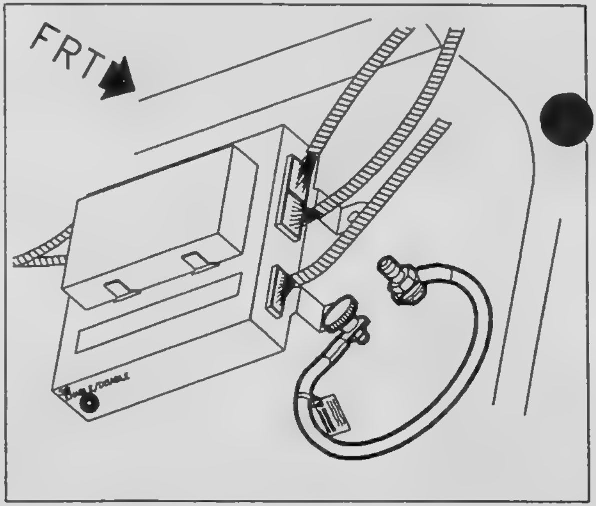
INSTALLATION

1. Place key pad in LOCK mode.
2. Remove the four fasteners that retain the RH or LH junction block.
3. Install junction block ground strap/straps to junction block using the captured fasteners as illustrated and tighten to 10 N•m +/− 2 N•m (89 in−lbs +/− 18 in−lbs).
4. Install the loose end of the junction block ground strap to the junction block mounting stud on front dash, using the existing nut.

REMOVAL

1. Remove the junction block ground strap from the junction block, RH and LH sides if necessary.
2. Mount the junction block to the front of dash and torque to 10 N•m +/− 2 N•m (89 in−lbs +/− 18 in−lbs).



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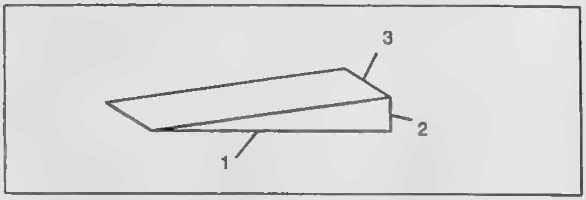
HOIST.

CAUTION: TO HELP AVOID PERSONAL INJURY, ALWAYS USE JACK STANDS WHEN WORKING ON OR UNDER ANY VEHICLE THAT IS SUPPORTED ONLY BY A FLOOR JACK OR A HOIST.

NOTICE: **When lifting with a frame contact hoist, and battery pack removal is not necessary, lift the vehicle on the body side frame-lower pinch weld flanges at specific lift locations. (Location views on next page).**

NOTICE: **Because of the uniqueness of the design of the EV1 and its ground clearance, it is necessary to follow the hoisting directions very carefully. With an inground two post front and rear hoist, it may be necessary to use either low profile arms or ramps as needed in the front lift pad area to keep the fascia from being damaged when approaching or leaving the hoisting area. Ramp size needed:**

1. **1050 mm in length (41-3/8 in.)**
2. **155 mm in height (6-7/64 in.)**
3. **230 mm in width (9-1/16 in.)**



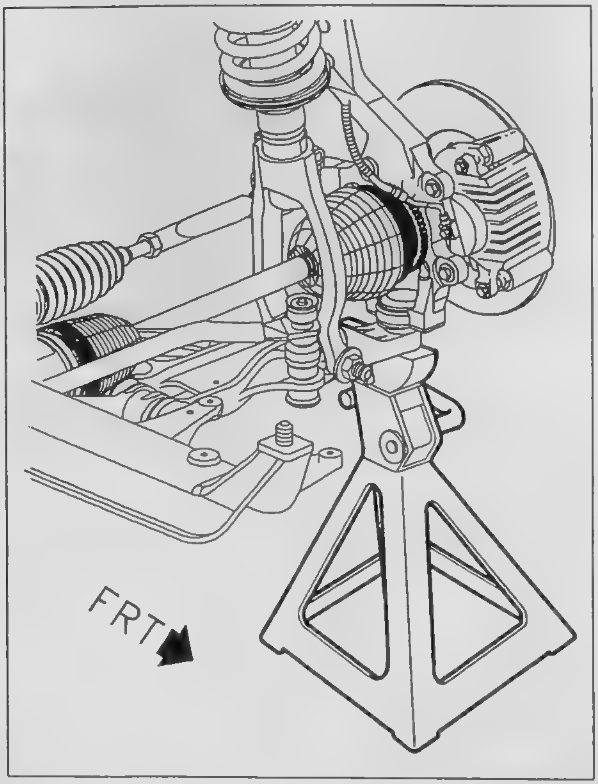
NOTICE: **When lifting with a suspension contact hoist, position the front hoist lift pads under the lower control arms. Lift from under the rear tires for rear suspension. (Refer to "Hoisting/Lifting for a Two Post In Ground Hoist Front and Rear" in this section for more information and illustrations.)**

When battery pack removal is required, the use of two rear lift pad adaptors must be used. These lift pad adaptors are obtainable from:

General Motors Dealer Equipment

Telephone: 1-800-GM-TOOLS

TOOL NUMBER	TOOL DESCRIPTION
EV9708E	Drive Motor Support Adaptor Kit
EV9711E	Drive Motor Support/Liftplate
EV9719T	Drive Motor Seal Installer
EV9732Z	Oil Pressure Switch Socket
EV9713Z	Junction Box Ground Strap
EV9718Z	Fluke 87 Multimeter
EV9735Z	Digital Insulation Tester
EV9714Z	Battery Pack To PIM Extension Cable W/DVM
EV9735Z	Digital Insulation Tester



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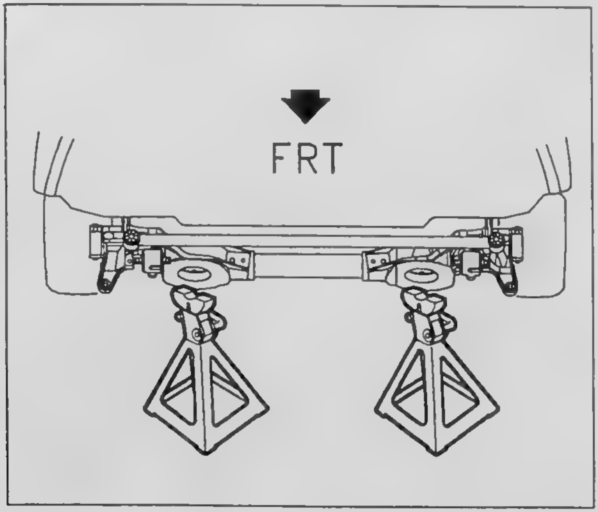
3. Once the vehicle is at the required working height install safety stands.



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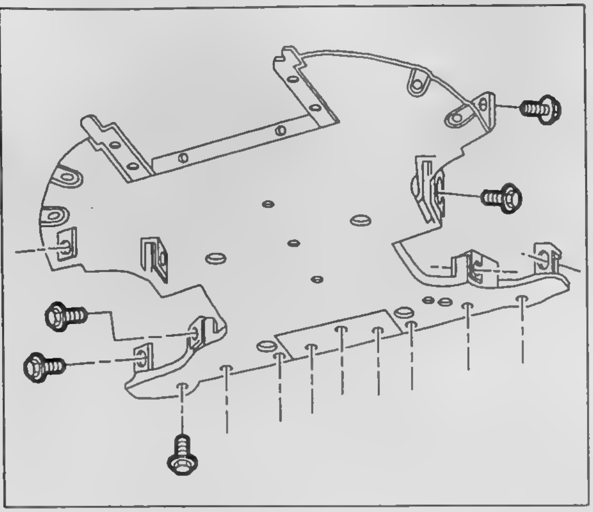

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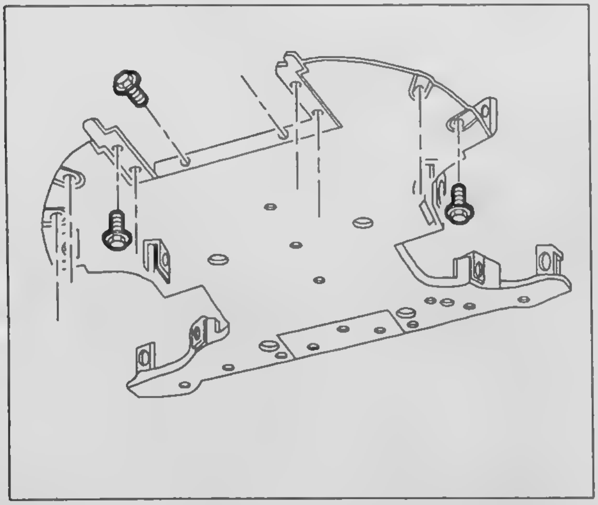
UNDERBODY FRONT AIR DEFLECTOR

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting, Jacking, and Support Points" section in this manual.)
2. Remove bolts retaining underbody front air deflector to underbody center air deflectors.
3. Remove bolts retaining underbody front air deflector to front wheelhouse panel liners.



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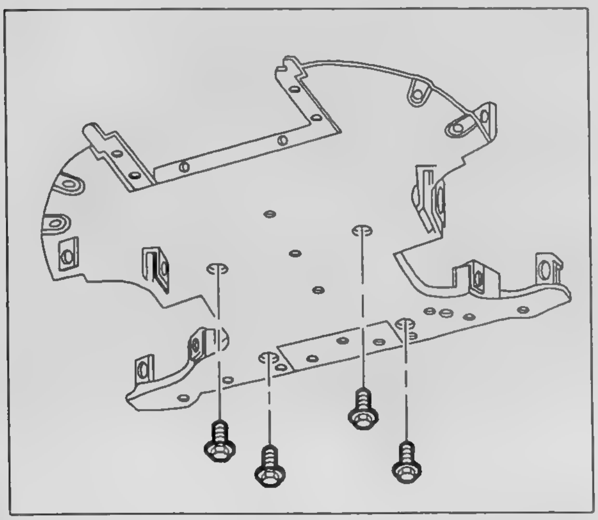
4. Remove bolts retaining underbody front air deflector to front bumper fascia assembly.
5. Remove bolts retaining underbody front air deflector to condenser radiator fan module (CRFM) bracket.
6. Remove bolts retaining underbody front air deflector to side baffles.



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7. Remove bolts retaining underbody front air deflector to drivetrain and front suspension crossmember assembly.
8. Lower underbody front air deflector and disengage tabs from front bumper fascia assembly.

INSTALLATION

IMPORTANT: If bolt threads or "J" nuts threads are damaged during removal or installation, remove bolt and fastener, inspect, and replace if necessary.

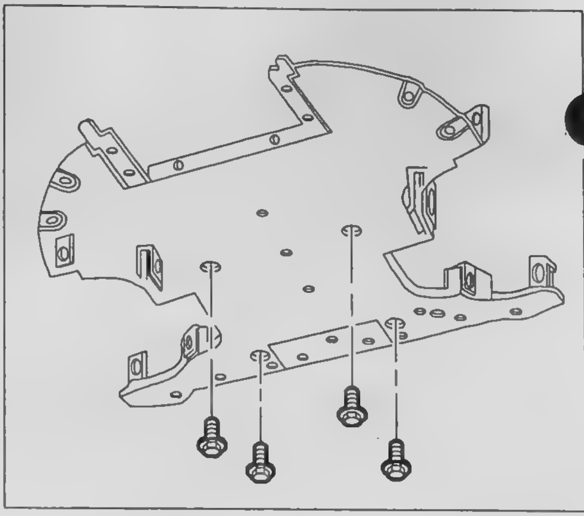
1. Raise front edge of air deflector and engage tabs into retaining slots on front bumper fascia assembly.
2. Raise and support underbody front air deflector to underside of vehicle.

IMPORTANT: Flange on air deflector must be located forward of Condenser Radiator Fan Module (CRFM) bracket.

3. Loosely install bolt retaining air deflector to CRFM bracket.
4. Loosely install bolts retaining underbody front air deflector to front mounting locations of drivetrain and front suspension crossmember assembly.
5. Loosely install bolts retaining underbody front air deflector to rear mounting locations of drivetrain and front suspension crossmember assembly.
6. Install and tighten bolts retaining underbody front air deflector to underbody center air deflectors. Torque as specified.

Torque: **6 N•m (53 in – lbs)**

IMPORTANT: If cradle bolt begins to cross thread during installation, stop immediately, remove bolt, then run thread tap (M6.0 mm x 1.0) into insert to repair damaged threads.



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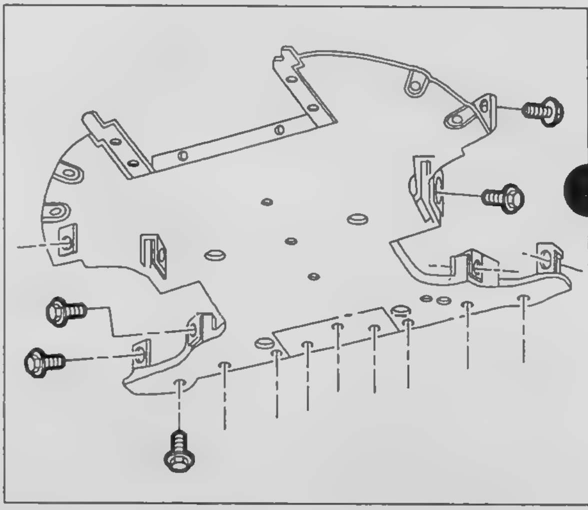

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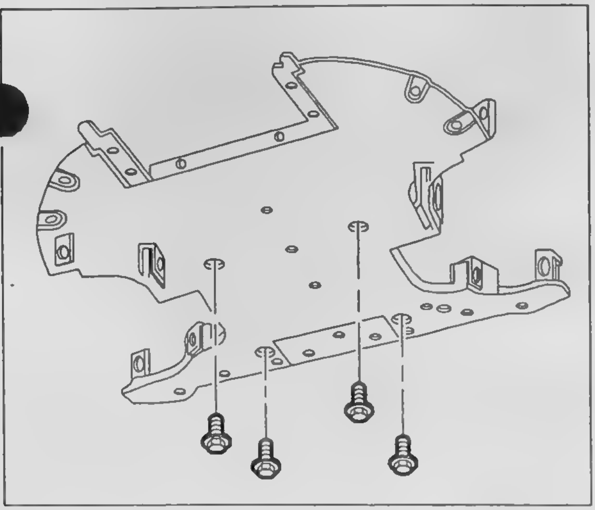

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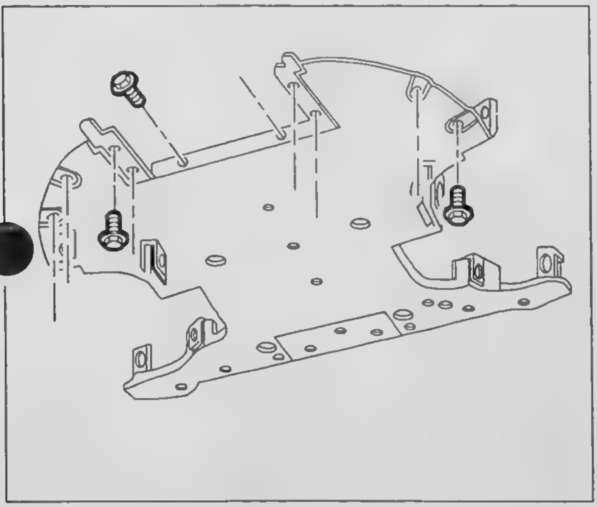
7. Tighten bolts retaining underbody front air deflector to front mounting locations of drivetrain and front suspension crossmember assembly. Torque as specified.

Torque: **6 N•m (53 in–lbs)**



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IMPORTANT: At CRFM attachment, position air deflector flange so that it rests up against the bottom of the CRFM lower support.

8. Install and tighten bolt retaining underbody front air deflector to CRFM bracket. Torque as specified.

Torque: **6 N•m (53 in–lbs)**

9. Tighten remaining bolt retaining air deflector to CRFM bracket. Ensure underbody front air deflector is up against bottom of CRFM lower support. Torque as specified.

Torque: **6 N•m (53 in–lbs)**

10. Install and tighten bolts retaining underbody front air deflector to CRFM to fascia close-out side baffles. Torque as specified.

Torque: **6 N•m (53 in–lbs)**

11. Install and tighten bolts retaining underbody front air deflector to front bumper fascia assembly. Torque as specified.

Torque: **6 N•m (53 in–lbs)**

12. Install and tighten bolts retaining underbody front air deflector to front wheelhouse panel liner on one side of the vehicle. Front tires may need to be rotated to access mounting locations. Torque as specified.

Torque: **6 N•m (53 in–lbs)**

13. Install and tighten bolts retaining underbody front air deflector to front wheelhouse panel liner on opposite side of the vehicle. Front tires may need to be rotated to access mounting locations. Torque as specified.

Torque: **6 N•m (53 in–lbs)**

14. Lower vehicle and turn front wheels to face in a straight ahead position.

PROPULSION CONTROL MODULE – SYMPTOM DIAGNOSIS

PRELIMINARY CHECKS

VERIFY COMPLAINT

Verify the customer complaint and locate the correct symptom definition. Check all of the items associated with that symptom in both the complaint/condition charts and symptom tables.

GATHER INFORMATION

Gather information from all resources available to pinpoint the "when," "where," "why," and "how" of the symptom. Road test with the customer when possible to completely understand the symptom. Compare the symptom to a similar vehicle to verify this is an abnormal condition. Find out (when applicable), maintenance history, typical driving cycle, charging habits, etc. Perform a bulletin search focusing on specific symptoms.

VISUAL INSPECTION

The importance of the visual inspection cannot be overstressed. Visual inspection can lead to correcting a problem without further testing and can save valuable time. The check should include:

- Use of aftermarket equipment (e.g., alarm systems, cellular phones, lighting, CB radio, etc.).
- Inspect wiring harnesses for proper routing, connections, pinches, chaffing and cuts.
- Inspect grounds for tightness and evidence of corrosion.

SECTION 1 – DIAGNOSTIC INFORMATION

VISUAL/PHYSICAL UNDERHOOD INSPECTION

A careful visual and physical underhood inspection must be performed as part of any diagnostic procedure or in finding the cause of a failure. This can often lead to fixing a problem without further steps. Inspect all hoses for correct routing, pinches, cuts or disconnects. Inspect all wires in the motor compartment for proper connections, burned or chafed spots, pinched wires, or contact with sharp edges. This visual/physical inspection is very important. It must be done carefully and thoroughly.

KNOWLEDGE AND TOOLS REQUIRED

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. One should be familiar with wiring diagrams, the meaning of voltage, ohms, amps, frequency, the basic theory of electricity, and understand what happens in an open or shorted wire.

To perform system diagnosis, the use of a diagnostic Scan tool is required. A digital ohmmeter with 10 megohms impedance, and jumper wires are also required. Please become acquainted with the tools and their use before attempting to diagnose a vehicle.

DIAGNOSTIC INFORMATION

The diagnostic trouble tree charts and functional checks in this manual are designed to locate a faulty. circuit or component through logic based on the process of elimination. The charts are prepared with the requirement that the vehicle functioned correctly at the time of assembly and that there are no multiple failures. Trouble tree charts are designed to be used only when a diagnostic trouble code DTC is active.

The PCM performs self-diagnostics of propulsion control functions. The PCM communicates faults with a system of diagnostic trouble codes (DTCs). These DTCs may or may not turn on a telltale.

DTC TEST DESCRIPTIONS

The Scan tool will display whether the DTC in the PCM's memory is current or history. The following describes the current/history criteria for each DTC.

Current – A current DTC indicates that the last time a diagnostic test was performed on a particular system or sub-system it failed. For DTCs indicated as latched for ignition cycle, a problem may no longer exist, but the DTC will not clear until vehicle has been powered Off/On.

History – A history DTC indicates there have been enough faults detected to determine a problem exists.

For diagnostic trouble codes that are calibrated to tu[rn] On telltales on the first occurrence, DTCs will be stored in history as soon as a fault becomes current.

It is important to remember that the DTC as well as any stored malfunction history will be erased if the vehicle battery has been disconnected or a clear DTC command is issued to the PCM.

MALFUNCTION RECORDS

With all faults, the PCM stores vehicle information int[o] a memory called related data. This information is data for a DTC that caused the DTC to set. The Saturn portable diagnostic tool displays this information in EV Scanner PCM under the MALF HISTORY REC # directory as failure record. Malfunction history records the same data plus additional information and stores it in failure records numbered one through five.When the total recorded failures exceeds five the last stored failure will be removed and the most recent installed as #5.

"LAST STORED 5," will store the following:

- CYC SIN LAST
- CYC SIN FIRST
- # OF OCCURENCES
- #1 FAULT DTC
- MINUTES IN RUN
- PSOC %
- PCM BP VOLTS
- BP CURRENT
- SLIP (HZ)
- CURRENT CMD %
- BCA PHASE VLT %
- BCA PHASE CUR
- REGEN DISABLE
- RETARD REQ %
- PPS1 %
- PPS2 %
- PPS3 %
- PPS1 MINIMUM %
- PPS2 MINIMUM %
- PPS3 MINIMUM %
- PEB TEMP
- STATOR
- OIL PRESSURE
- HV INTERLOCK
- AUX BATT VOLT
- COAST DOWN SW

- PRND MODE
- PCM COUPLER IN
- C/C SET SPD KPH
- C/C STATUS
- C/C MODE
- CRUISE R/A SW
- CRUISE S/C SW
- CRUISE ON/OFF SW
- SERVICE BRAKE

Refer to "Scan Tool" definitions for more information.

UPDATING DTCS GREATER THAN FIVE

When five PCM DTCs are set and the sixth fault occurs, the first four DTCs set will remain and the last DTC will be updated with the new DTC (sixth DTC). If additional DTCs set the first four DTCs will remain as the originals and the last DTC will update for each fault.

IGNITION CYCLES

Ignition cycle: An ignition cycle is defined as PCM awake and vehicle speed greater than 16 km/h (10 mph) has been seen.

READING DIAGNOSTIC TROUBLE CODES

The provision for communicating with the PCM is the data link connector (DLC). It is located under the instrument panel near the left kick panel. It is used in the assembly plant to receive information in checking that the propulsion system is operating properly before it leaves the plant.

The DTC(s) stored in the PCM's memory can be read only through a hand-held diagnostic Scan tool plugged into the DLC connector when the vehicle is turned On.

CLEARING DIAGNOSTIC TROUBLE CODES

DTCs may be cleared in the all codes test on the Scan tool. Disconnecting the auxilliary battery for 60 seconds (and in some cases longer) will clear DTCs, active and history from the PCM's memory. Malfunction history records will also be cleared.

DLC SCAN TOOLS

The PCM can communicate a variety of information through the DLC. This data is transmitted at a high-frequency which requires a Scan tool for interpretation. There are several Scan tools available for reading this information.

With an understanding of the data which the tool displays and knowledge of the circuits involved, the tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

Scan tools do not make the use of diagnostic charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. DTC charts incorporate diagnosis procedures using a Scan tool where possible. Most charts require the use of a Scan tool.

The Scan tool helps reduce diagnosis time and prevent the replacement of good parts. The key to using the Scan tool successfully for diagnosis lies in the technician's ability to understand the system being diagnosed, as well as an understanding of the Scan tools operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

SCAN TOOL USAGE WITH INTERMITTENTS

In some Scan tool applications, the data update rate makes the tool less effective than a voltmeter, such as when trying to detect an intermittent problem which lasts for a very short time. However, the Scan tool can be used to observe parameters while manipulating wiring harnesses or components under the hood with the vehicle in the Run mode.

The Scan tool can also be used to monitor parameters while driving the vehicle to duplicate intermittent conditions. Examples of intermittent conditions would include telltales coming on briefly and going off and intermittent driveability problems. An assistant should be used when driving a vehicle and using a Scan tool. If the problem seems to be related to certain parameters that can be checked on the Scan tool, they should be checked while driving the vehicle. Each pertinent parameter on the Scan tool can be monitored to see if there is any change in the readings that might relate to or explain the intermittent condition.

The Scan tool is also an easy way to compare the operating parameters of a poorly operating system with those of a known good one. For example, a sensor may shift in value but not set a DTC. Comparing a sensor's readings with those of a known good vehicle may uncover the problem.

The PCM has the ability to take a snapshot when a DTC is stored. This information can be found with a Saturn Scan tool (portable diagnostic tool [PDT]), listed under Malfunction history. This information can be very useful when attempting to troubleshoot intermittent DTCs.

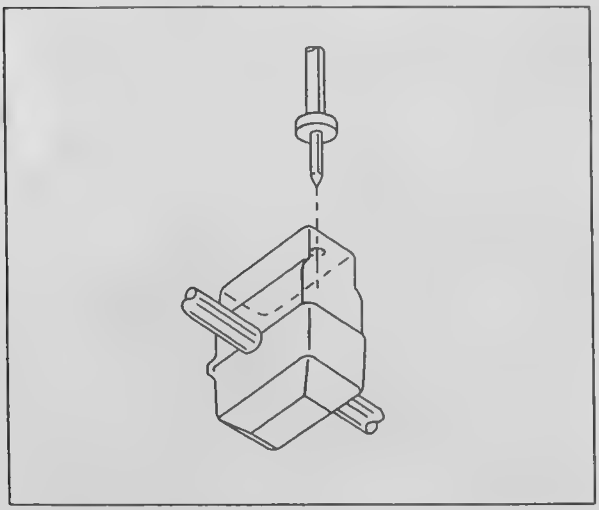
DIAGNOSTICS USING THE DIAGNOSTIC SERVICE PROBE

DIAGNOSTIC SERVICE PROBE

IMPORTANT: Diagnostic service probes are for use on .35, .50 and .80 mm (22, 20 and 18 gage) wires only.

IMPORTANT: The diagnostic service probes must be left on the wire after use. The probe contains a sealant that will protect the wire from corrosion. Do not remove the diagnostic service probe after use.

The use of the diagnostic service probe offers many advantages in system diagnostics over the old *jumper wire* and *terminal back-probe* methods. The most important advantage of the diagnostic service probe method of diagnostics is the ability to observe the operation of a circuit without disturbing the components or connections. This is an important advantage since many circuit failures are vibration or connection related. The diagnostic service probe is designed to firmly hold multimeter test probes to allow more accurate readings while the circuit is operating. Circuits with bad connectors, grounds or components are easier to diagnose while they are operating.



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Attach the diagnostic service probe to the wire leading to the connector and insert your multimeter into the diagnostic service probe. Put the meter on the appropriate scale and observe the readings. If the readings do not compare with the expected readings, gently wiggle the wire back and forth in the connector. If the reading on the meter changes while you are wiggling the wire, the terminal or connector are faulty. Disconnect the connector and examine the terminals and connector cavities for damage. Check the terminals to see if a known good terminal makes a firm connection. Do this by inserting a known good male terminal into the female terminal you are testing. The male terminal should be held firmly in place by the female terminal and should not be loose enough to fall out if the female terminal is held downward. Likewise, test a male terminal by inserting it into a known good female terminal. The two terminals should fit snugly together and should not separate if the male terminal is held vertically downward.

If the connections are good (both wire connections and the connection to the component), check the ground connection. Attach a diagnostic service probe to the ground side of the circuit or component. Place a multimeter probe in the diagnostic service probe and the other probe to a known good ground.

Place the multimeter on the lowest ohmmeter scale.

NOTICE: **Check the accuracy of the multimeter first by touching the leads together. The meter should read less than 0.10 ohm with the leads touching.**

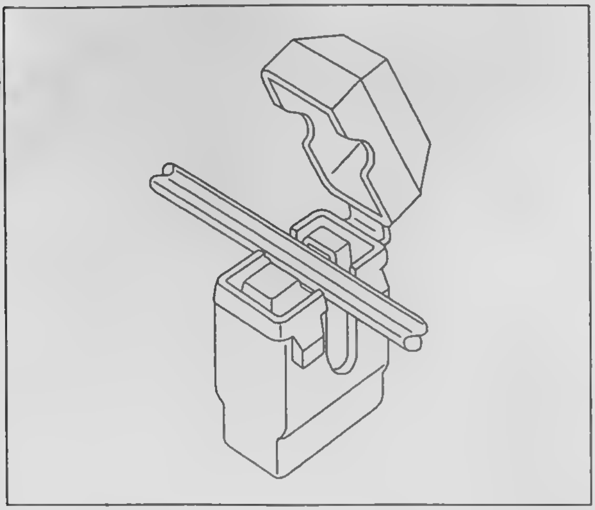
The meter should read less than one ohm. If the meter reads more than one ohm, check the connections to the ground splice pack (if applicable) or check the ground attachment point. Attach a jumper wire from the ground attachment ring terminal. Attach it to the ring terminal without moving or disturbing the terminal fastener. This can be done by attaching the jumper wire to the crimp lead part of the ring terminal. Attach the other end of the jumper wire to a known good ground and watch the multimeter to see if the reading goes below one ohm. If the reading goes below one ohm, remove the ground screw or nut, clean the connection surfaces and install. If the reading stays above one ohm, check for an open in the ground wire. Also check for continuity from the component to the diagnostic service probe.

Other uses for the diagnostic service probe:

- Compare voltage readings across connectors, components, or lengths of wire. This allows you to observe the operation of a circuit without the addition of jumper wires or back-probing connections. The best time to diagnose most circuits is while they are operating.
- Observe changing voltages and compare them to what the PCM is reporting. This can be done by comparing the voltage readings of the PCM inputs to the reported PCM readings displayed on the portable diagnostic tool (PDT) or the service stall system (SSS). This can help detect damaged or faulty PCM connections, or a faulty PCM.

IMPORTANT: There are differences between the actual voltages from the sensors and the reported voltages by the PCM. This is due to the internal conversion of these voltages to binary data by the PCM. However, the voltages should generally vary together and the difference should be less than 0.2 volt.

- The diagnostic service probe can be used with future test equipment to gain access to a circuit for testing or calibration.
- The diagnostic service probe can be used to give a good ground access point. Attach a diagnostic service probe to a ground circuit and insert the multimeter lead in the probe at a ground reference. Check the ground circuit to verify the ground path is good.



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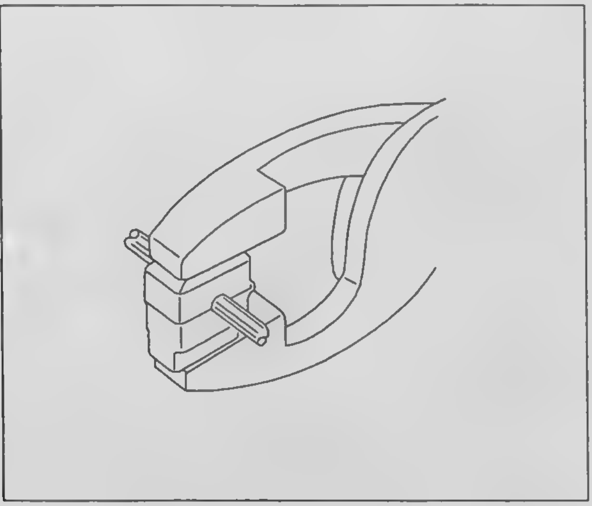
INSTALLATION

1. Place the cable into the V-slot of the terminal.
2. Press the cable into the V-slot by hand and initiate closing the cover.



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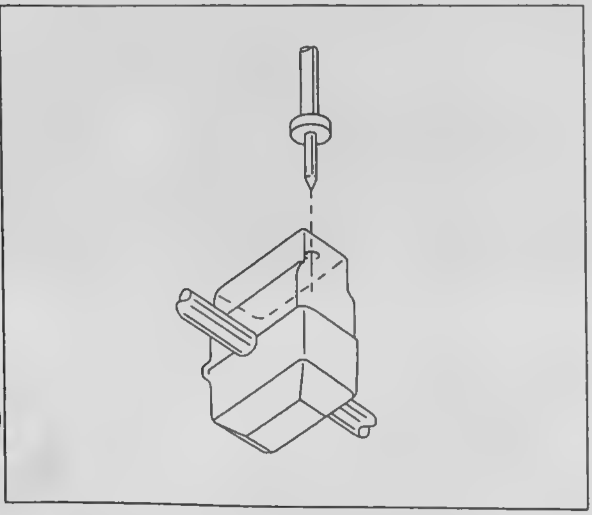
3. Close the cover completely by pressing the cable into the diagnostic service probe terminal with pliers until the cover locks shut. A snap should be felt or heard when the cover locks.
4. To probe the wire, insert the multimeter probe into the housing through the gel to contact the terminal. The housing has a thin wall of material to pierce with the multimeter probe. In some locations the multimeter probe should be used to pierce the probe opening, before the probe is installed on the wire.

IMPORTANT: Once the probe is installed, it should not be removed. The diagnostic service probes were designed to stay on the wires permanently. The gel material inside the probe will seal the wire and allow the wire to be probed several times.



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EV–SCANNER–PCM

GENERAL INFO

PARAMETER	SCAN TOOL DISPLAY	DEFINITION
SLIP (HZ)	0–20	The amount of slip sent to the BCA from the PCM for motor current command. The greater the slip the more torque applied to the motor.
MOTOR SPD RPM	0–16000	The speed the rotor is turning measured by the speed and direction sensor.
SPD MPH xx KPH xx	0–162	The Vehicle speed calculated by the PCM. The PCM receives this signal from the BCA which receives this input from the speed/direction sensor.
MTR CURR CMD %	10–90%	This is a PWM output signal from the PCM to the BCA and represents the commanded current value to control the drive motor.
PHASE CURR MON	0–462.5	This is an analog signal that represents the AC current measured at the output to the drive motor.
PRND MODE	"PARK," "REVERSE," "NEUTRAL," "DRIVE" OR "INVALID"	This signal represents the position the PCM sees from the PRND switch on the Drive Motor.
TORQUE CMD	−100% TO 100%	Displays the PCM torque command based on various inputs.
RAW SHAFT DIR	"FWD" OR "REV"	Displays "FWD" when the rotor is turning on the CW direction (as viewed from the right side of the motor).
SHAFT DIR	"FWD" OR "REV"	This signal is received by the PCM from the BCA. The PCM can determine vehicle direction by the amplitude of the signal. Above 2000 RPM the signal is filtered.
SHAFT SPD NOISY	"YES" OR "NO"	Displays "YES" when one of the two conditions have been met: 1) Shaft speed is > 2000 RPM and a change in shaft direction was seen in 8ms. 2) The shaft speed has increased or decreased more than 2000 RPM in 8ms.
SHAFT SPD FAULT	"YES" OR "NO"	Displays "YES" when a fault is detected.
SHAFT DIR FAULT	"YES" OR "NO"	Displays "YES" when a fault is detected.
SLIP DIR	"FORWARD" OR "REVERSE"	This represents the commanded slip direction from the PCM to the BCA. Two slip signals are sent to the BCA. One defines the torque commanded, the other defines the direction.
PROP STATUS	"NORMAL" OR "FAILED" OR "REDU–PERF"	This represents the state the PCM is operating under.
PCM BP VOLTS	0–500	This represents the battery pack voltage as read by a scaled input (1V = 100V) to the PCM.
AUX BATTERY	0–25.5	This represents the auxiliary battery voltage as seen at the PCM input.
STATOR	−40 to 216C −40 to 420.8 F	This represents the temperature of the motor stator windings as read by the PCM.
PEB TEMP	−39.75 to 151.5 C −40 to 304.7 F	This represents the temperature at the cold plate of the PIM as read by the BCA and sent to the PCM for display.

EV–SCANNER–PCM (Continued)

GENERAL INFO

PARAMETER	SCAN TOOL DISPLAY	DEFINITION
RETARD REQ%	0–100%	This is the amount of Retard/Regen the BTCM is requesting to aid in slowing the vehicle and preventing wheel slip. 18% = NO request.
RETARD ACH%	0–100%	This represents the amount of Retard/Regen the PCM was able to obtain based on other inputs. I.E. at 100% USOC the amount of allowable regen will be very small.
C/C SET SPD	0–162 KPH	Displays the vehicle speed when cruise was selected.
C/C STATUS	"STANDBY," "ACCELER," "COAST", "RESUME," "CRUISE" OR "TAP"	Displays current status as seen by PCM: Standby = Not in C/C, cruise switch off, VS < 30 MPH or PCM sees service brake input. cruise = driving with cruise set. "ACCELER"/"COAST"/"RESUME"/"TAP" = Functions of cruise control switch.
C/C MODE	"OFF", "ENABLE" OR "DISENG"	Displays the mode of operation as seen by the PCM.
C/C DRVR OVRIDE	"YES" OR "NO"	Displays "YES" when a driver input is activated to disable cruise: brake switch/gear position change.
PPS1%	0–100%	Displays the accelerator position in percent, the percentage is converted from PPS1 by the PCM and rescaled so that: 0% = Closed; 99% = WOT. Reads 0% with charge coupler in.
PPS2%	0–100%	Displays the accelerator position in percent, the percentage is converted from PPS2 by the PCM and rescaled so that: 0% = Closed, 99% = WOT. Reads 0% with charge coupler in.
PPS3%	0–100%	Displays the accelerator position in percent, the percentage is converted from PPS3 by the PCM and rescaled so that: 0% = Closed, 99% = WOT. Reads 0% with charge coupler in.
PPS1 VOLTS	0–5 Volts	The APA indicates throttle position to the PCM. The APA contains three individual sensors that are scaled differently. PPS1 volts is the raw voltage read by the PCM on PPS1. PPS1 Range: .25–1.05V closed throttle, 4.32–4.57V WOT.
PPS2 VOLTS	0–5 Volts	The APA indicates throttle position to the PCM. The APA contains three individual sensors that are scaled differently. PPS2 volts is the raw voltage read by the PCM on PPS2. PPS2 Range: 3.94–4.75V closed throttle .375–.625V WOT.
PPS3 VOLTS	0–5 Volts	The APA indicates throttle position to the PCM. The APA contains three individual sensors that are scaled differently. PPS3 volts is the raw voltage read by the PCM on PPS3. PPS3 Range: 3.70–4.30V closed throttle, 1.58–1.83V WOT.
PPS1 MINIMUM%	0–100%	Displays the minimum PP the PCM has learned. The PCM will learn the minimum PP at each power-up. This PP value has to be exceeded to apply torque to the motor.
PPS2 MINIMUM%	0–100%	Displays the minimum PP the PCM has learned. The PCM will learn the minimum PP at each power-up. This PP value has to be exceeded to apply torque to the motor.
PPS3 MINIMUM%	0–100%	Displays the minimum PP the PCM has learned. The PCM will learn the minimum PP at each power-up. This PP value has to be exceeded to apply torque to the motor.

EV–SCANNER–PCM (Continued)

GENERAL INFO

PARAMETER	SCAN TOOL DISPLAY	DEFINITION
PEDAL POSITION%	0–100%	Displays the position of the accelerator pedal based on the operators input. 0 = closed throttle and WOT ≥ 90%. Always reads 0% with charge coupler in.
PPS STATUS	"VALID" OR "LEVEL 1" OR "LEVEL 2" OR "LEVEL 3"	Displays the state of the accelerator pedal as defined by the PCM inputs. "VALID IF THE THREE PEDAL POSITION SENSOR READINGS ARE WITHIN A SPECIFIED RANGE."
PPS1 FAILED	"YES" OR "NO"	Displays "YES" if PCM has detected a failure with PPS1.
PPS2 FAILED	"YES" OR "NO"	Displays "YES" if PCM has detected a failure with PPS2.
PPS3 FAILED	"YES" OR "NO"	Displays "YES" if PCM has detected a failure with PPS3.
PPS1 & 2 MATCH	"OK" OR "DISAGREE"	The PCM determines failures of the PPS by comparing voltage levels. If the voltage levels of two sensors do not represent the same pedal position the PCM will set a DTC and this will display "DISAGREE."
PPS2 & 3 MATCH	"OK" OR "DISAGREE"	The PCM determines failures of the PPS by comparing voltage levels. If the voltage levels of two sensors do not represent the same pedal position the PCM will set a DTC and this will display "DISAGREE."
PPS1 & 3 MATCH	"OK" OR "DISAGREE"	The PCM determines failures of the PPS by comparing voltage levels. If the voltage levels of two sensors do not represent the same pedal position the PCM will set a DTC and this will display Disagree.
BTSI LOCK	"YES" OR "NO"	Displays "YES" when the BTSI is locked by PCM command. "YES" = RUN/ACC Mode in park W/brake not applied or during charging w/brake applied. "NO" = In Park w/brake applied or in any gear.
TEMP TT	"ON" OR "OFF"	Displays "ON" when a request for the temperature telltale to turn On is made. "ON" when TEMP TT is being commanded by: BPM, PCM or HTCM.
SEC VIOLATION	"YES" OR "NO"	Displays "YES" if: 1) PCM sees an incorrect password from the RSA on power-up. 2) RSA does not receive a send message from PCM after 5 seconds. 3) No communication. 4) RSA receives three incorrect key codes at door keypad.
REDUCED PERF TT	"YES" OR "NO"	Displays "YES" when the PCM is commanding the REDUCED PERFORMANCE Telltale On. This may be a request from another controller.
SERVICE NOW TT	"ON" OR "OFF"	Displays "ON" when the SERVICE NOW telltale is commanded On by: BPM, PCM, or HTCM
BCA FAULT RESET	"YES" OR "NO"	At start-up or if a clear DTC is sent the PCM will send this signal to the BCA to clear its fault registers. Displays "YES" when the PCM is clearing the BCA's fault registers.
SERVICE SOON TT	"ON" OR "OFF"	Display "ON" when a request for the SERVICE SOON telltale has been made by the: PCM, BPM, HTCM, or BTCM.
BIAS FAULT INPUT	"YES" OR "NO"	This signal is sent to the PCM when the BCA detects a fault with the bias supply or bias voltage is lost. Displays "YES" when a fault has been detected and the BCA will shut down.

EV–SCANNER–PCM (Continued)

GENERAL INFO (Continued)

PARAMETER	SCAN TOOL DISPLAY	DEFINITION
PCM COUPLER IN	"YES" OR "NO"	Displays "YES" when the PCM has detected the coupler is present in the charge receptacle.
SOFTWARE ID		
PCM S/W ID	XXXXXXXX	Displays the 8-digit number for identifying the PCM software. If value is 97020000, then download new software.
S/W CHECKSUM	XXXX	Displays the software checksum. If value is 0000, then download new software.
VEHICLE ID		
ID	XXXXXXXXXXXXXX XXX	Displays the vehicle identification number (VIN).
END MODEL	XXXXXXXX	Displays the end model number of the PCM as defined by the supplier.
BASE MODEL	XXXXXXXX	Displays the base model number of the PCM.
HARDWARE ID	XX	Displays the 2-digit hardware ID of the PCM.
SERIAL NO	XXXXXXXX	Displays the 8-digit serial number of the PCM.
MFG YEAR LAST DIG	XX	Displays the year the module was made.
MODULE NO	XXXXXXXX	Displays the 8-digit module number.

PCM MALFUNCTION HISTORY RECORDS

PARAMETER	SCAN TOOL DISPLAY	DEFINITION
CYC SIN LAST	0–255	Displays the number of ignition cycles since last occurrence of the fault.
CYCLE SIN FIRST	0–255	Displays the number of ignition cycles since the first occurrence of the fault.
# OF OCCURRENCES	0–255	Displays the number of times the fault reoccurred.
#1 FAULT DTC	1–120	Displays the fault DTC that was set.
MINUTES IN RUN	0–255	Displays the number of minutes the vehicle was in the RUN/ACC mode before the DTC set.
PSOC%	0–100%	The pack state of charge when the DTC set.
PCM BP VOLTS	0–500 Volts	Displays the battery pack voltage as seen by the PCM at the time of the fault.
BP CURRENT	–400 to 400 amps	Displays what the BPM was reading as current at the time of fault.
TORQUE REQ	–100 to 100	Displays the sum of all the torque inputs. The torque request is used to produce the current and slip commands.
SLIP (HZ)	.4–20 HZ	Displays the amount of slip being commanded to the BCA for motor operation.

PCM MALFUNCTION HISTORY RECORDS (Continued)

PARAMETER	SCAN TOOL DISPLAY	DEFINITION
CURRENT CMD%	0–100%	Displays the current command to the motor for propulsion. This is a PWM signal.
BCA PHASE% VLT	0–100%	Displays a scaled voltage at one of the phases. This is a feedback signal to the PCM from the BCA.
BCA PHASE CUR	0–462.5 amps	Displays the current at one of the phases. This is a feedback signal to the PCM from the BCA.
REGEN DISABLE	Yes or NO	Displays the status of regen. YES = regen was commanded by the BTCM to be disabled.
RETARD REQ%	0–100%	Displays the amount of retard/regen being commanded at the time of the failure. Zero retard request = 18%
PPS1%	0–100%	Displays the accelerator position in percent. The percentage is converted from the PPS1 by the PCM. 0% = closed throttle, 99% = WOT.
PPS2%	0–100%	Displays the accelerator position in percent. The percentage is converted from the PPS2 by the PCM. 0% = WOT, 99% = closed throttle.
PPS3%	0–100%	Displays the accelerator position in percent. The percentage is converted from the PPS3 by the PCM. 0% = closed, 99% = WOT.
PPS1 MINIMUM%	0–100%	Displays the minimum PP the PCM has learned. The PCM will learn the minimum PP at each power-up. Start at 100% and scales down to current pedal rest position. This new PP value will have to be exceeded to apply torque to the motor.
PPS2 MINIMUM%	0–100%	Displays the minimum PP the PCM has learned. The PCM will learn the minimum PP at each power-up. Start at 100% and scales down to current pedal rest position. This new PP value will have to be exceeded to apply torque to the motor.
PPS3 MINIMUM%	0–100%	Displays the minimum PP the PCM has learned. The PCM will learn the minimum PP at each power-up. Start at 100% and scales down to current pedal rest position. This new PP value will have to be exceeded to apply torque to the motor.
PEB TEMP	−40 to 190 degrees C	Displays the temperature the BCA is reading from the sensor at the coldplate.
STATOR	−40 to 216 degrees C	Displays the temperature the PCM is reading from the sensor laminated into the motor stator windings.
OIL PRESSURE	Yes or NO	Displays "YES" when the sensor is reading oil pressure.
HV INTERLOCK	Yes or NO	Displays "YES" when the PCM has detected an interlock failure.
COAST DOWN SW	Yes or NO	Displays the position of the coast down button on the shifter. YES = coast down.
PRND MODE	Error, Park, Reverse, Neutral or Drive	Displays the PRND position as read by the PCM from the PRND switch.
PCM COUPLER IN	Yes or NO	Displays "YES" if the PCM detects the charge coupler in the charg receptacle.

PCM MALFUNCTION HISTORY RECORDS (Continued)

PARAMETER	SCAN TOOL DISPLAY	DEFINITION
C/C SET SPD KPH	0–162 KPH	Displays the vehicle speed at which the cruise control button was pushed.
C/C STATUS	Standby, Accelerate, Resume, Coast, Cruise, or Tap	Displays the mode of cruise control operation at the time of the failure.
C/C MODE	Off, Enable, or Disengage	Displays the enable mode at the time of the failure. Disengage = Operator input, i.e. brake switch.
CRUISE R/A SW	Yes or NO	Displays "YES" if the Res/Accel button was pressed at the time of the failure.
CRUISE S/C SW	Yes or NO	Displays "YES" if the Set/Coast button was pressed at the time of the failure.
CRUISE ON/OFF SW	ON or OFF	Displays "ON" if the ON/OFF button was in the ON position at the time of the failure.
SERVICE BRAKE	Yes or NO	Displays "YES" if the brake pedal was depressed (as seen by the PCM) at the time of failure.

HIGH VOLTAGE SAFETY

CAUTION: DC AND AC HIGH VOLTAGE. TO HELP AVOID INJURY, ALWAYS FOLLOW THE SERVICE MANUAL PROCEDURES AND MANUALLY DISCONNECT THE HIGH VOLTAGE SYSTEM BEFORE WORKING ON OR AROUND IT.

The EV1 has both high voltage DC and AC systems, as well as a 12-volt system. DC and AC high voltage are both very dangerous and can cause severe burns and shock. You first need training about how to repair the EV1 and then must follow the proper repair procedures to minimize the risk.

Currents as low as 0.5 ma AC OR 2 ma DC can cause injuries under some conditions. The potential for injury depends on the current path through the body, the amount of current and how long the current flows through the body. Other factors that influence the effect of current are the body's impedance, the frequency of the current, the moisture level of the skin, the size of the contact area, the pressure exerted, temperature, and the physiological characteristics of the individual.

AC and DC high voltage affect the body differently. The varying current with AC high voltage is more traumatic to the body and can also prevent letting go of the electrodes.

The high voltage system is independent and isolated from the 12-volt system. When a failure is detected, the high voltage system is automatically disconnected. There is also a manual disconnect that must be used before service work is performed on or around the high voltage system.

To help avoid injury:

- Do not work on the EV1 without training. Even the greatest gasoline engine technician needs training for this vehicle.
- Follow the service manual procedures and cautions.
- ALWAYS assume that high voltage is present.
- To prevent current from having a path through your body, use one hand to do operations in high voltage systems and keep the other hand in your pocket. Also, do not stand barefoot on wet cement.
- Use electrical tape to cover all metal parts of your tools to reduce the chance that the tools will complete a current path.

The battery pack has at least 25 times the energy of one regular automotive battery. Extra precautions are necessary when the battery pack is removed from the car because the automatic and manual disconnect cannot protect you from a disconnected battery pack. Follow the service manual procedures and cautions.

HIGH VOLTAGE SYSTEM

The high voltage system consists of the battery pack, power inverter module, accessory AC and DC power control module (APM) and systems, power steering control module (PSCM) and systems, drive motor and charge receptacle.

All of the HV components are interlocked. The interlock is a low voltage circuit that runs next to all of the high voltage circuits as the high voltage goes from one system to another. If an open or ground occurs in the high voltage circuit (e.g., disconnecting a HV connector with relays closed) the interlock will detect this open and shut the high voltage down by opening the relays.

BATTERY PACK

The battery pack always has high voltage DC present. The nominal voltage of the battery pack is 312 volts. The voltage may be higher during charging or regeneration. The voltage in the battery pack flows to the vehicle (PIM) through two large relays. When these relays are closed the 312 volts is present at the PIM. Under normal operating conditions the relays are always closed. However, the relays are opened if a fault in the high voltage system is detected or the manual disconnect is removed.

If the battery pack is removed from the vehicle additional steps must be taken to reduce the voltage to a safe level for working on the battery pack. Some diagnostic procedures will require you to work with the pack at 312 volts and care must be taken to follow the service manual procedures and use safe practices, like using one hand when performing operations and taping your tools with electrical tape.

POWER INVERTER MODULE (PIM)

The power inverter module (PIM) is a distribution center for the high voltage. The PIM distributes high voltage DC power from the battery pack to the APM (22 A MAX), PSCM (5 A MAX), and the convert power function (propulsion power to the drive motor). The PIM will also distribute high voltage DC power to the battery pack from the charge receptacle and the convert power function during regeneration from the drive motor. The APM, PSCM, and the convert power function (part of bias and control assembly [BCA] inside of the PIM) receive DC power and convert the DC to AC power for the appropriate applications.

When the relays are closed the PIM stores a significant amount of energy using battery pack voltage, in two large capacitors. When the battery pack HV relays are opened these capacitors are discharged through the bus discharge assembly. The bus voltage must be reduced to 42.4 volts within 250 milliseconds of the relays opening. If a failure occurs in the bus discharge assembly that prevents the bus from discharging, high voltage will be present even though the relays are open. If this condition occurs follow the steps in high voltage present with relays open chart in this section of the service manual.

ACCESSORY AC AND DC POWER CONTROL MODULE (APM)

The APM receives its high voltage from the PIM. The APM uses this voltage to provide power to three main functions:

1. Convert DC to three phase AC for compressor control
2. Power a DC power supply for auxiliary battery charging
3. Provide DC power for the heated windshield

A high voltage cable runs from the APM to the compressor motor. If this connector is disconnected the compressor control function will be shut down. The cable also contains a ground shield to provide a ground path in the event that a compressor motor has shorted. There is an additional ground strap from the case of the motor to chassis that forms a redundant ground. The compressor motor is a high voltage component and is isolated from chassis ground. The ground paths prevent the components from having a high voltage potential to chassis ground. The compressor has a voltage sense lead attached to the motor case to detect the presence of a voltage potential. If a voltage potential appears on the compressor motor the HTCM will set a DTC 25, turn on the Service Soon telltale, and disable the compressor operation.

POWER STEERING CONTROL MODULE (PSCM)

The PSCM receives its high voltage from the PIM. The PSCM uses this voltage to provide power to the power steering pump for operation. The power steering pump motor is three phase AC. A high voltage cable runs from the PSCM to the power steering pump motor. If this connector is disconnected the power steering control function will be shut down. The cable also contains a ground shield to provide a ground path in the event that the power steering motor shorts. There is a redundant ground strap from the case of the motor to chassis ground. The power steering motor is a high voltage component and is isolated from chassis ground. The ground paths prevent the components from having a high voltage potential to chassis ground. The PSCM, like the compressor, has a case voltage sense lead. If a voltage potential appears on the power steering pump, the HTCM will detect this, set DTC 40, and turn on the SERVICE SOON telltale. If the ground is lost the power steering motor interlock circuit is opened disabling the pump.

DRIVE MOTOR

The drive motor receives its high voltage from the convert power function inside of the PIM. Enabling this function allows the high voltage DC to be converted into high voltage AC for drive motor power. The drive motor is three phase AC. The drive motor HV is passed through a blind mate connector. There is no cable between the PIM and drive motor. It is a pin to pin contact (blind mate connector). However the drive motor does contain a case ground strap to chassis ground. The drive motor is a high voltage component and is isolated from chassis ground. The ground paths prevent the components from having a high voltage potential to chassis ground.

The convert power function is also used to enable regeneration. During braking or coast down the drive motor AC power recovered is converted to DC and passed from the PIM to the battery pack for charging the batteries.

CHARGE RECEPTACLE

The charge receptacle receives its high voltage from one of two chargers. The convenience charger works off of 110V outlets and standard charge modules are wired to 220V power. The charge receptacle converts this AC power to DC power. This DC power is passed through the PIM HV bus to the battery pack for charging the battery modules. Any open or shorting of the charge receptacle will be sensed by the auto disconnect system and the drive motor battery pack module (BPM) will shut off the charging function.

AUTO DISCONNECT (AD) SYSTEM

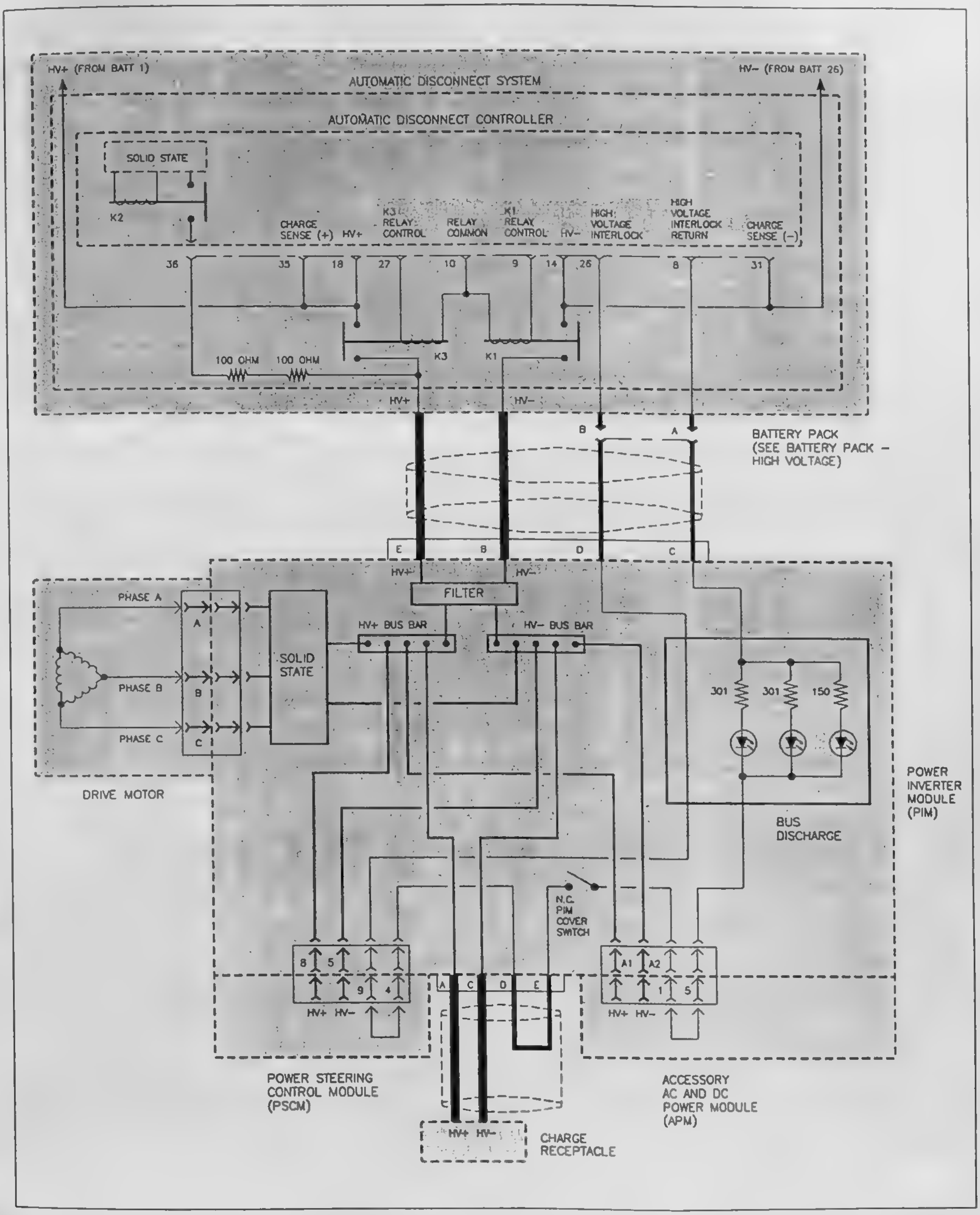
The AD systems opens and closes the HV relays. This system will detect and open the relays under the following conditions:

- Precharge failure: Attempt to close HV relays failed
- DC and some AC isolation failures: Resistance measured from HV + and − bus to chassis ground.
- Interlock Loop: Low voltage circuit detect
- Chassis ground: Loss of chassis ground reference for isolation detection
- Ground Sense: Redundant chassis ground reference
- Under voltage fault: AD not receiving required HV from batteries
- BPM command: BPM commanded relays open

Detailed information on these functions can be found in the AD system section of this service manual.

MANUAL DISCONNECT

The manual disconnect is located behind the drivers seat. When the manual disconnect knob is turned the interlock loop opens. The AD system will detect this and open the relays. The knob can then be pulled out which will open the series string of the batteries between battery modules 13 and 14. If the relays are not opened due to a failure removing the manual disconnect will reduce the HV potential at the HV harness connector to the PIM. If this occurs refer to the service manual high voltage present chart.



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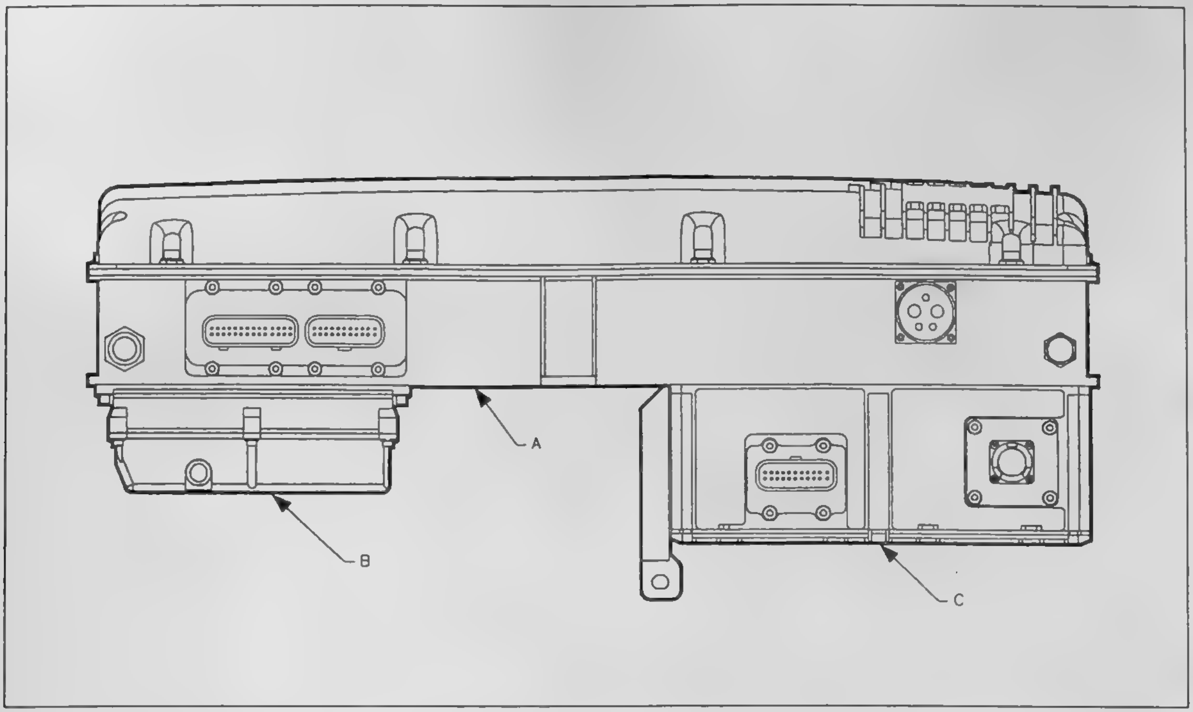
DESCRIPTION AND OPERATION



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A – Drive motor power inverter module (PIM)

B – Power steering control module (PSCM)

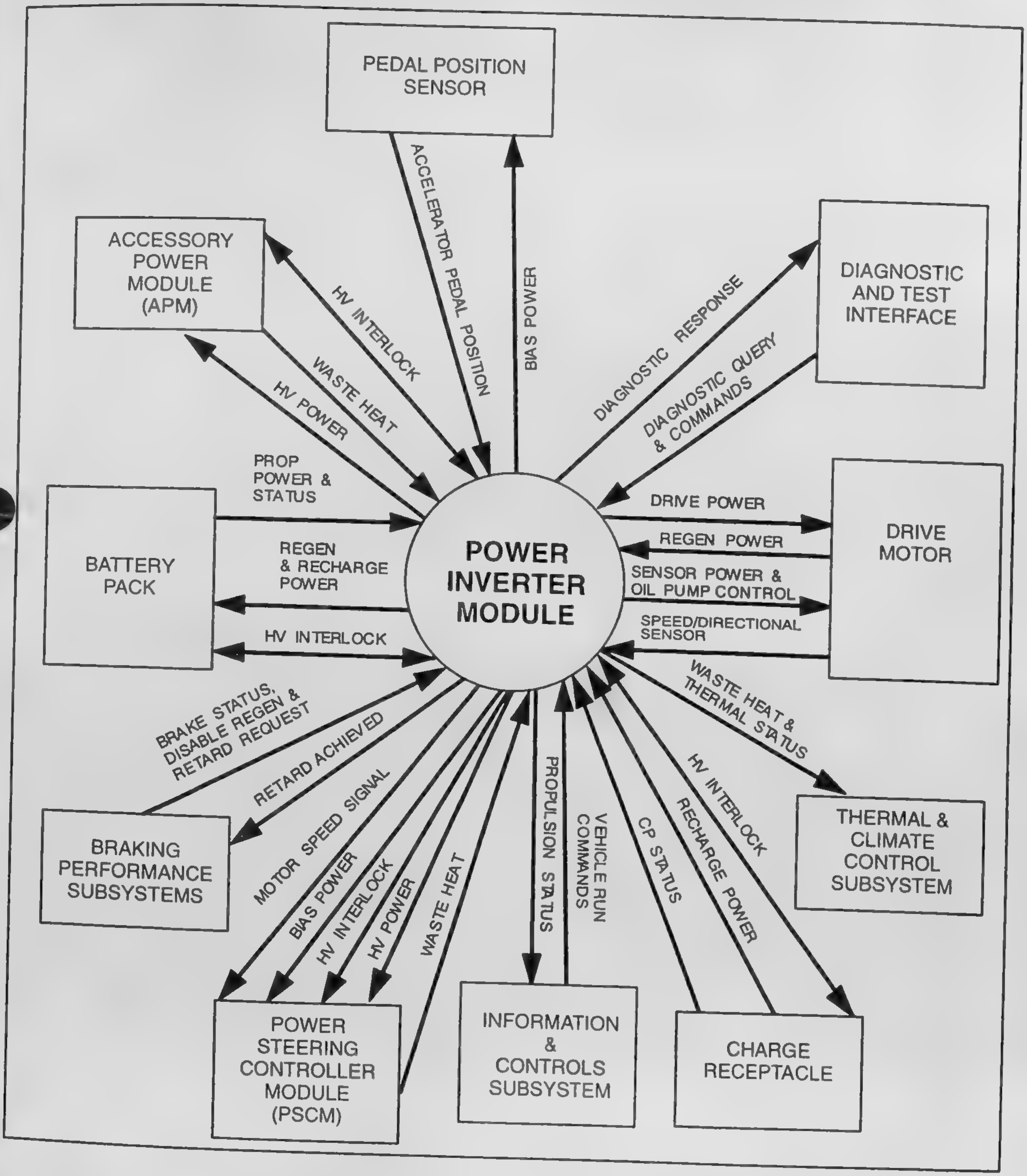
C – Accessory AC and DC power module (APM)

The PEB consists of the accessory AC and DC power module (APM), power steering control module, (PSCM), and power inverter module (PIM).

The PEB handles the high voltage AC/DC conversions for the drive motor and is the power source for many of the vehicles components. It uses inputs from various systems on the vehicle to optimize the control of the drive motor, battery power use, heated windshield, compressor, power steering motor and has many other functions related to the thermal system, charging system and cruise control system.

POWER INVERTER MODULE (PIM) EXTERNAL INTERFACES DESCRIPTION

The PIM interacts with the other components/subsystems of the vehicle as shown in the PIM functional context diagram. The PIM functional interfaces are described below.



PIM Functional Context Diagram

POWER INVERTER MODULE (PIM)

The PIM is the main HV distribution center for the vehicle. Its operating range is 225 to 430 volts DC and zero to 400 amps. With the PIM disconnected from all other components, the isolation (resistance) between either HV DC terminal and the PIM chassis must be at least 1.9MΩ

The PIM, which contains the propulsion control module (PCM), interfaces with many of the vehicles subsystems and components. These interfaces allow the PIM to:

- Control AC propulsion power to the drive motor.
- Invert high voltage (HV) DC into AC for drive motor propulsion power.
- Convert AC power, created from the drive motor during Regenerative mode, into DC power that is used for battery charging.
- Distribute HV DC power to non-propulsion PEB functions.
- Perform status monitoring, status reporting and diagnostic tests for internal and related external functions.

The PIM has four major components: propulsion control module (PCM), bias and control assembly (BCA), bus discharge assembly and isolated gate bipolar transistors (IGBT).

PCM (PROPULSION CONTROL MODULE)

The PCM is located in the PIM on the right hand side. The PCM controls the EV1 motoring functions using various driver and vehicle inputs. PCM functions include:

- Determining PRND mode
- Reading pedal position sensor inputs
- Cruise control
- Creep
- Coast-down drag
- Vehicle speed limiting based on failures
- Regenerative brake blending
- Battery voltage limiting during motoring
- Battery voltage limiting during Regen
- Motor and inverter control signal generation
- PIM and Drive Motor temperature monitoring
- Oil Pump control
- On-board diagnostics

BCA (BIAS AND CONTROL ASSEMBLY)

The bias and control assembly is like another PCM except controlling different functions. The BCA provides 12 volt power and ground for the speed/direction sensor. It receives and processes the speed and direction signal and sends it to the PCM. The BCA also monitors and asserts the high voltage within the PIM based on the current and slip commands from the PCM. If the BCA detects a fault in its system it will send a message to the PCM for it to set a code and store related data.

BUS DISCHARGE ASSEMBLY

The bus discharge assembly is responsible for dissipating all of the stored energy of the bus when the high voltage (HV) relays are opened. The energy is dissipated through eight resistors on the discharge board. The bus must discharge to 42.5 volts in 250 ms. A failure to discharge the bus will cause high voltage to remain present at all of the PIM high voltage connectors with the high voltage relays open.

IGBT (ISOLATED GATE BIPOLAR TRANSISTOR)

The IGBTs are high power transistors used to convert the DC voltage to AC and provide current to the three phase drive motor. They also provide the AC to DC conversion during Regen to recharge the batteries.

There are six hybrid power modules (HPM) in the PIM, two HPMs per motor phase. One HPM is connected to the positive bus for each motor phase and the other is connected to the negative bus. Each HPM contains six IGBTs, 12 IGBTs per motor phase.

The BCA produces gate drive signals for the HPMs based on slip and current commands. The HPMs create a sine wave by toggling between the positive HV bus and the negative bus. This along with the characteristics of the motor is what produces the sine wave or DC to AC conversion.

POWER INVERTER MODULE (PIM) INTERFACES

HIGH VOLTAGE INTERLOCK LOOP

All of the high voltage DC connectors and cover switch are tied together in an isolated series single wire interlock loop. The PIM monitors the high voltage interlock loop circuit. If the loop is broken anywhere, the PIM will discharge the bus capacitors to less than 42.4 volts within 250 milliseconds.

The PIM also contains a regeneration shutdown function that monitors the HV interlock power. The PIM will prevent the regeneration function within milliseconds after the loss of HV interlock or loss of HV power.

DRIVE MOTOR

The PIM receives high voltage DC from the battery pack and converts this voltage into three phase AC that is supplied to the drive motor during the propulsion mode. During Regen mode the drive motor sends AC voltage back to the PIM which is converted into DC and supplied to the battery pack for storage. The PIM also supplies sensor power to the drive motor speed/direction sensor and oil pump. The speed/direction sensor supplies the PIM with information on the drive motor shaft speed and the shaft direction. The oil pump is controlled by the PCM. The PCM monitors the oil pump pressure, drive motor temperature, PRND switch, and the speed/direction sensor.

DRIVE MOTOR PERFORMANCE LIMITING

The PCM will limit torque current and turn On the reduced performance telltale whenever one of the following conditions is active:

- PIM over-temperature
- Drive motor over-temperature
- Pedal position sensor failure
- Low battery pack voltage
- Oil pump failure

DRIVE MOTOR TORQUE NOT ALLOWED

The PIM will not provide torque to drive motor under the following conditions:

- PRND is in PARK or NEUTRAL
- High voltage interlock fault
- Internal PIM critical fault

VEHICLE SPEED LIMITING

The PIM will limit vehicle speed in the forward direction to 129 km/h (80 mph) and in the reverse direction to 48 km/h (30 mph).

DRIVE MOTOR SLIP

Drive motor slip is the difference between the rotor position and the magnetic field position that is acting on the rotor. It is similar in concept to timing on an internal combustion engine. The difference is that in an internal combustion engine there is combustion pressure pushing the engine, whereas in the electric motor there is magnetic attraction pulling the motor. Greater slip results in greater acceleration. Zero slip provides zero torque input to the motor. Negative slip pulls back on the stator and slows it down or makes it go in reverse. Whenever slip is acting to reduce the motor speed it also generates electricity which can be put back into the batteries.

The PCM calculates drive motor slip based on requested torque, battery voltage, drive motor shaft rate and direction, PRND mode, drive motor temperature and drive or braking status.

COAST DOWN FUNCTION

The EV1 is more aerodynamic and has lower rolling resistance than gasoline powered vehicles. With the PRND in D (drive) and the accelerator pedal released, the EV1 will coast freely like an automatic transmission in neutral. The coast down feature uses a calibrated amount of regenerative braking to gradually slow down the vehicle. The slow down feel with coast down enabled is similar to an automatic transmission in drive with the accelerator pedal released. The PCM controls coast down by providing a negative torque current as a function of drive motor shaft speed/direction sensor rate, accelerator position, and coast down drag.

CREEP FUNCTION

The EV1 is programmed to simulate the "creep," of a vehicle with an automatic transmission when the brake pedal is released at a stop. When the vehicle is stopped and in drive or reverse and the accelerator pedal position input indicates its minimum position, the PIM will provide a positive torque current to the drive motor. This allows the driver to creep forward up to about two mph with no accelerator pedal input.

REDUCED PERFORMANCE MODE

Reduced performance mode is a state in which drive motor power is limited to 8 kw. This is enough power to reach a speed of about 45 mph, but in a much longer time than usual. Reduced performance is primarily a protection mode for the vehicle. Reduced performance is entered when the user state of charge drops below zero percent to help protect the batteries. If the drive motor overheats the reduced performance helps it to cool off. Some diagnostic codes cause reduced performance mode for other reasons including safety.

The PIM will check PRND selection inputs, service brake status, drive motor speed/direction shaft, and charge connection status based on the chart below, to select the valid PRND and brake transmission safety interlock (BTSI) modes to command (refer to "Vehicle Speed Limiting).

PRND REQUEST	SERVICE BRAKE SWITCH	BTSI THRESHOLD SPEED $\geq$ 5 mph	CHARGE CONNECTION PRESENT	BTSI
PARK	ON	NO	TRUE	LOCK
PARK	ON	NO	FALSE	UNLOCK
PARK	ON	YES	TRUE	LOCK
PARK	ON	YES	FALSE	UNLOCK
PARK	OFF	NO	TRUE	LOCK
PARK	OFF	NO	FALSE	LOCK
PARK	OFF	YES	TRUE	LOCK
PARK	OFF	YES	FALSE	UNLOCK
REVERSE	–	–	–	UNLOCK
NEUTRAL	–	–	–	LOCK
DRIVE	–	–	–	LOCK

DRIVE MOTOR OIL PUMP SYSTEM

When the PCM receives RUN 1, the PCM will enable the oil pump relay for 15 seconds. After 15 seconds, the oil pump will not be enabled until the drive motor speed/direction sensor rate is greater than 1.6 km/h (1 mph). The oil pump will continue to run for three seconds after the vehicle drops below the 1.6 km/h (1 mph) threshold.

The PCM will monitor the oil pressure status when the oil pump relay is commanded On. The PCM will turn On the SERVICE NOW telltale if the oil pressure falls below 42 kPa (6 psi) while the pump is commanded On.

RUN1 AND RUN2

The PIM relies on information from the RSA for wake-up commands. The RSA signals the RHJB which supplies the PIM with RUN 1 and RUN 2 commands which allows the PIM to begin operation. The RUN 2 command must be preceded by a RUN 1 command. The delay between RUN 1 and RUN 2 is to allow the HV capacitors to charge before the HV loads are enabled. When RUN 1 is received the PCM will run a diagnostics/self test. When RUN 2 is received the PIM will initialize and the PCM will run power-up diagnostics of the PIM.

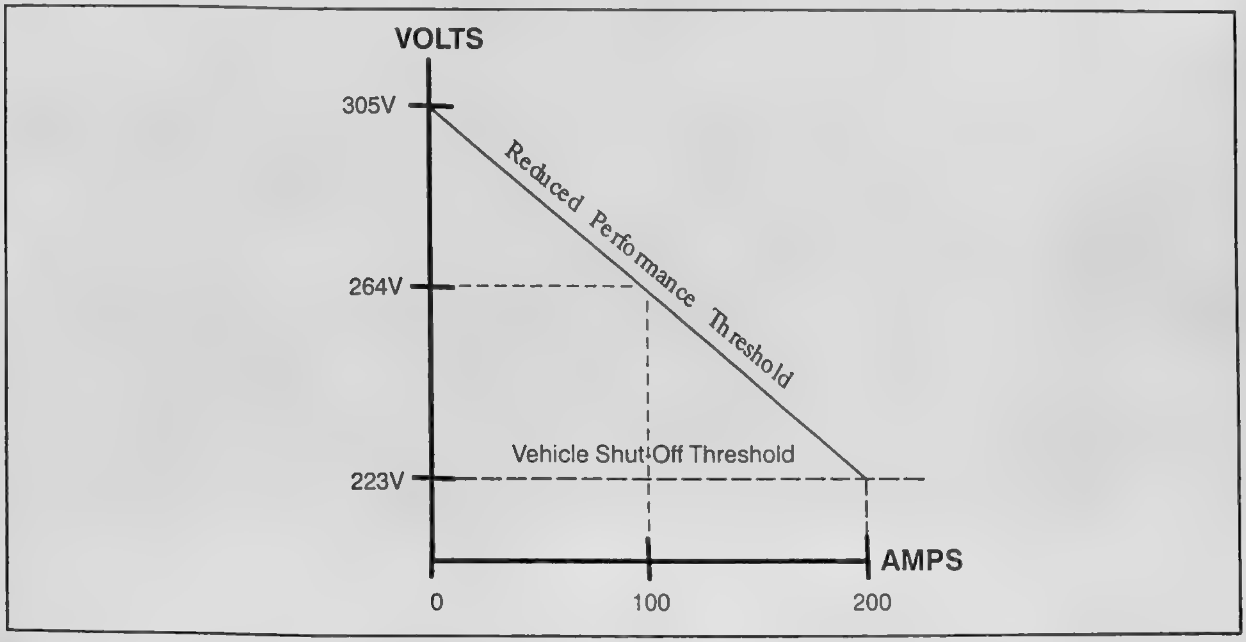
Functions performed upon receipt of a RUN 1 command:

- Security code exchange with RSA
- Control propulsion power
- Distribute HV power
- Power up PCM and PIM diagnostics
- Enable PCM serial data

Run 2 powers the BCA which controls PIM IGBT HV. The PCM provides the rest of the vehicle with propulsion data via serial data. The propulsion data can be viewed using the Scan tool. Scan tool data is listed at the beginning of this manual.

BATTERY PACK

The PIM receives and distributes all of the high voltage (HV) received from the battery pack. Additionally, the PIM converts and returns energy to the battery pack through regeneration from the drive motor. It also passes recharge power from the charge receptacle. The PIM and battery pack are linked with a HV interlock system. In the event the HV interlock opens the PIM disables propulsion and safely discharges HV bus stored energy. The PIM receives battery pack status for interlock and energy control and sends PIM status to the battery pack module (BPM). The PIM will decrease the current request or inhibit the convert power function based on the HV received from the battery pack. The PCM receives a scaled battery voltage (1V = 100 volts) from the bias control assembly (BCA). If the battery voltage/current falls below the solid line on the chart below for 30 seconds the PCM will enter reduced performance mode.



ACCELERATOR PEDAL ASSEMBLY (APA)

The PIM uses the accelerator pedal position inputs to help determine the current output to the drive motor. The PIM provides sensor power on three independent lines each feeding a separate potentiometer within the APA. These potentiometers each provide a feedback to the PIM of the pedal position. The sensors are scaled differently to provide error detection. The pedal position is converted to a current request based on vehicle speed and HV bus voltage. This information is coordinated with the braking performance subsystem inputs to achieve optimal performance. For more information on the PPS, refer to the APA section in this service manual.

BRAKING PERFORMANCE SUBSYSTEM

The PCM receives inputs from the braking subsystem to control regenerative current output from the drive motor. The PCM uses battery pack status, retard request, PRND mode, shaft rate and direction to calculate the maximum possible propulsion brake torque.

The braking subsystem outputs to PIM:

- Retard request
- Disable regeneration
- Service brake

The PCM will report the retard achieved status back to the braking subsystem. The PCM uses the service brake input during cruise operation to disable cruise control.

The PIM will not allow Regen torque if:

- PRND is in Park or Neutral
- Discrete Regen disable is active
- Redundant (serial) Regen disable is active
- Manual disconnect is open
- Pack voltage fault has occurred
- Retard request fault

REGENERATION

The PIM provides a regeneration function which allows the drive motor to supply negative shaft torque, that is, power back into the vehicle. In this mode the drive motor and PIM act as a generator feeding current back to the battery pack for storage.

The maximum allowed regeneration is 365 volts DC and 30 amps DC.

ACCESSORY POWER MODULE (APM)

The PIM provides filtered high voltage DC power to the APM for distribution with an associated HV interlock. The maximum amps supplied to the APM is 22 amps. The PIM conducts thermal energy from the APM. The PIM also supplies a ground path for the APM.

POWER STEERING CONTROLLER MODULE (PSCM)

The PIM provides filtered high voltage DC power to the PSCM with an associated HV interlock. The maximum current supplied to the PSCM is five amps. The PIM supplies the drive motor speed signal, the 12V bias (Run 2), and the 12V return to the PSCM.

The PIM also provides a chassis ground and conducts thermal energy from the PSCM.

For more information on the PSCM refer to the PSCM in the Electrical Service Manual.

CHARGE RECEPTACLE

The PCM receives power from the charge receptacle, filters it and provides high voltage DC to the batteries and operating accessories at the time of charging. The HV interlock passes in and out of the PIM and charge receptacle interface. The PIM monitors the charge receptacle and disables propulsion if the charge coupler is installed in charge receptacle. The PIM also provides a ground path for the charge receptacle.

CRUISE CONTROL

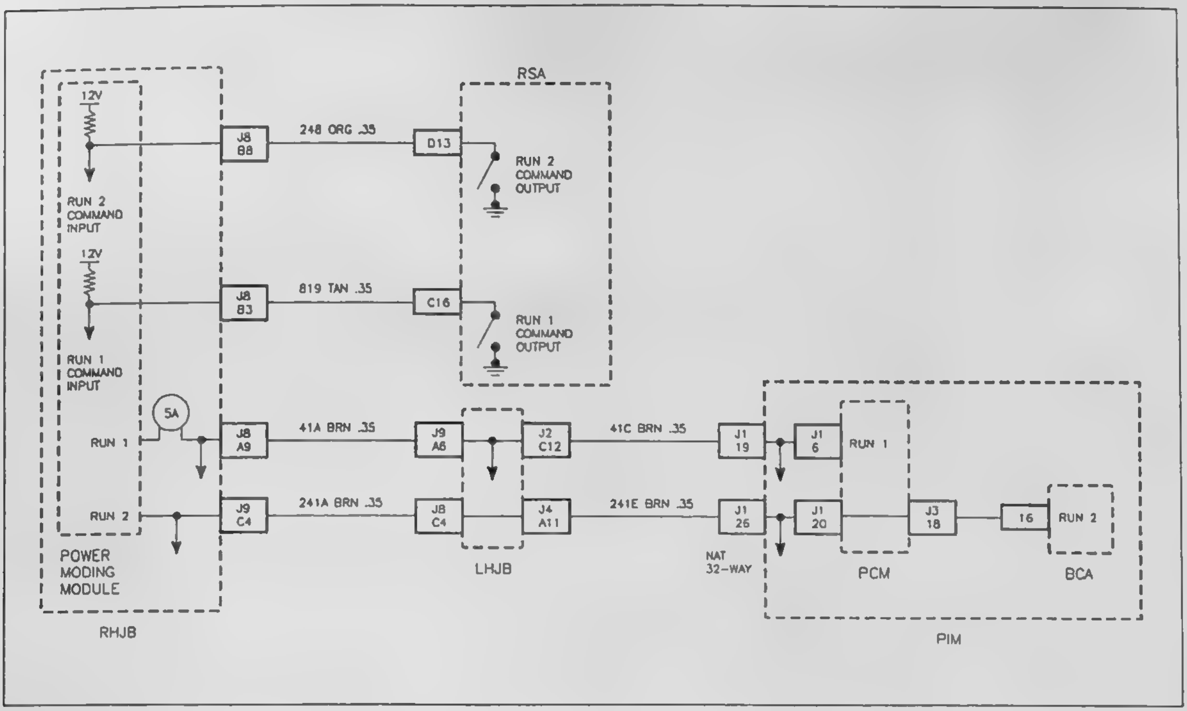
The PCM controls the cruise control system. The cruise control function will be enabled in drive mode only and will not be allowed during any speed select disable function events.

For more information on the cruise control system, refer to the "Cruise Control System Description" in this service manual.

NOTES

POWER ELECTRONICS BAY (PEB)

NO PROPULSION/RSA OPERATION IS OK/NO DTCS



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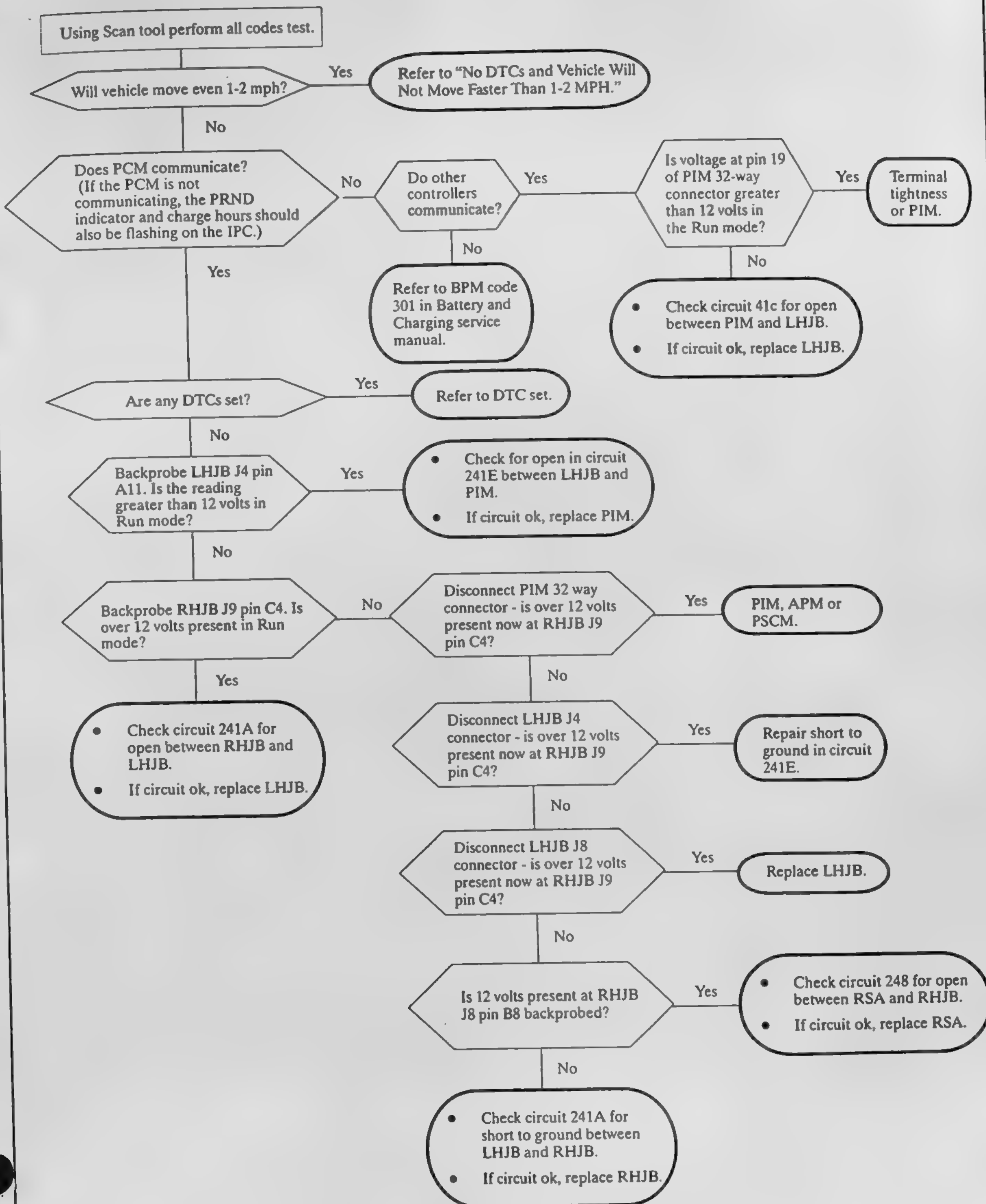
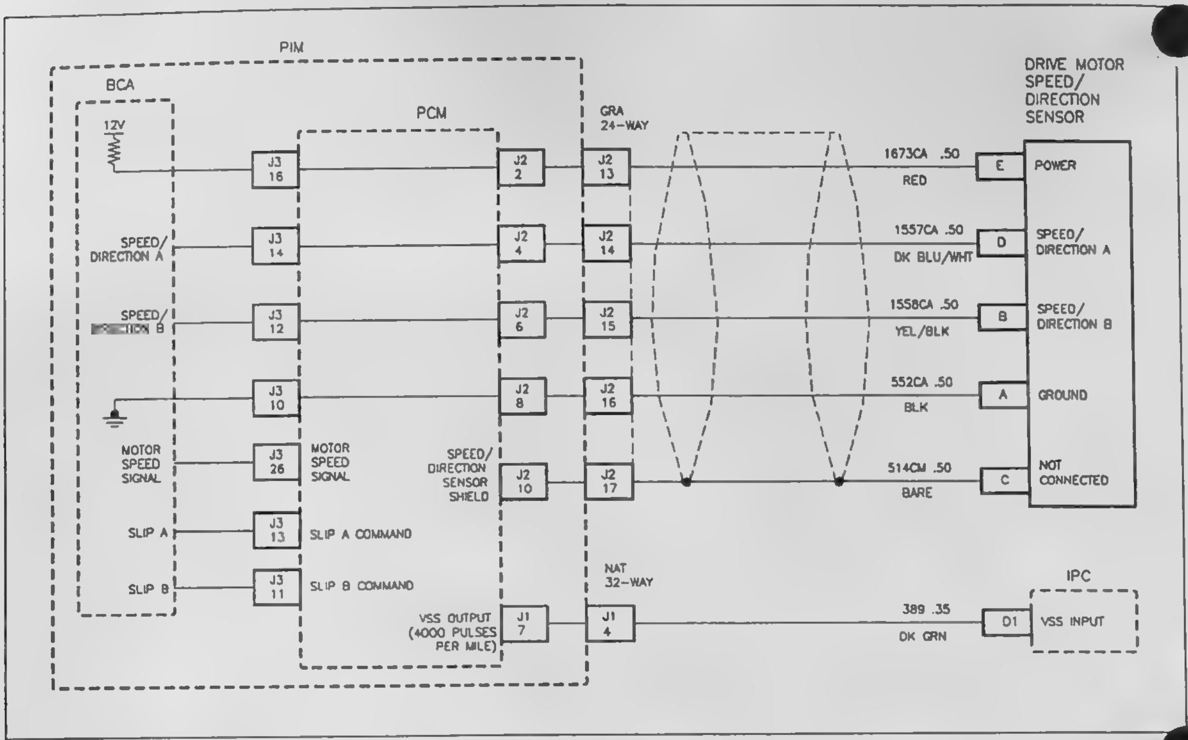
NO PROPULSION/RSA OPERATION IS OK/NO DTCS

In order for the propulsion control module (PCM) to operate it must receive the RUN 1 signal when the vehicle is placed in the Run mode. The loss of RUN 1 will cause the instrument panel control (IPC) to flash the PRND and CHARGE HRS display all the time, along with the range and user state of charge (USOC) bars every time the battery pack module (BPM) tries to communicate with the PCM. If Run 2 is lost the vehicle may be shifted out of park but propulsion will be disabled. Additionally, the bias control assembly (BCA) receives Run 2 from the run/lock shifter assembly (RSA) whenever the vehicle is in the Run mode. The Run 2 signal is passed through the PCM to the BCA. The BCA powers and controls the IGBTS. If the BCA does not receive Run 2 it will not power-up and there will be no propulsion. The PCM does not know the bias control assembly (BCA) has not received Run 2 on power-up and will not set a DTC.

NO PROPULSION/RSA OPERATION IS OK/NO DTCS



NO DTCS AND VEHICLE WILL NOT MOVE FASTER THAN 1–2 MPH



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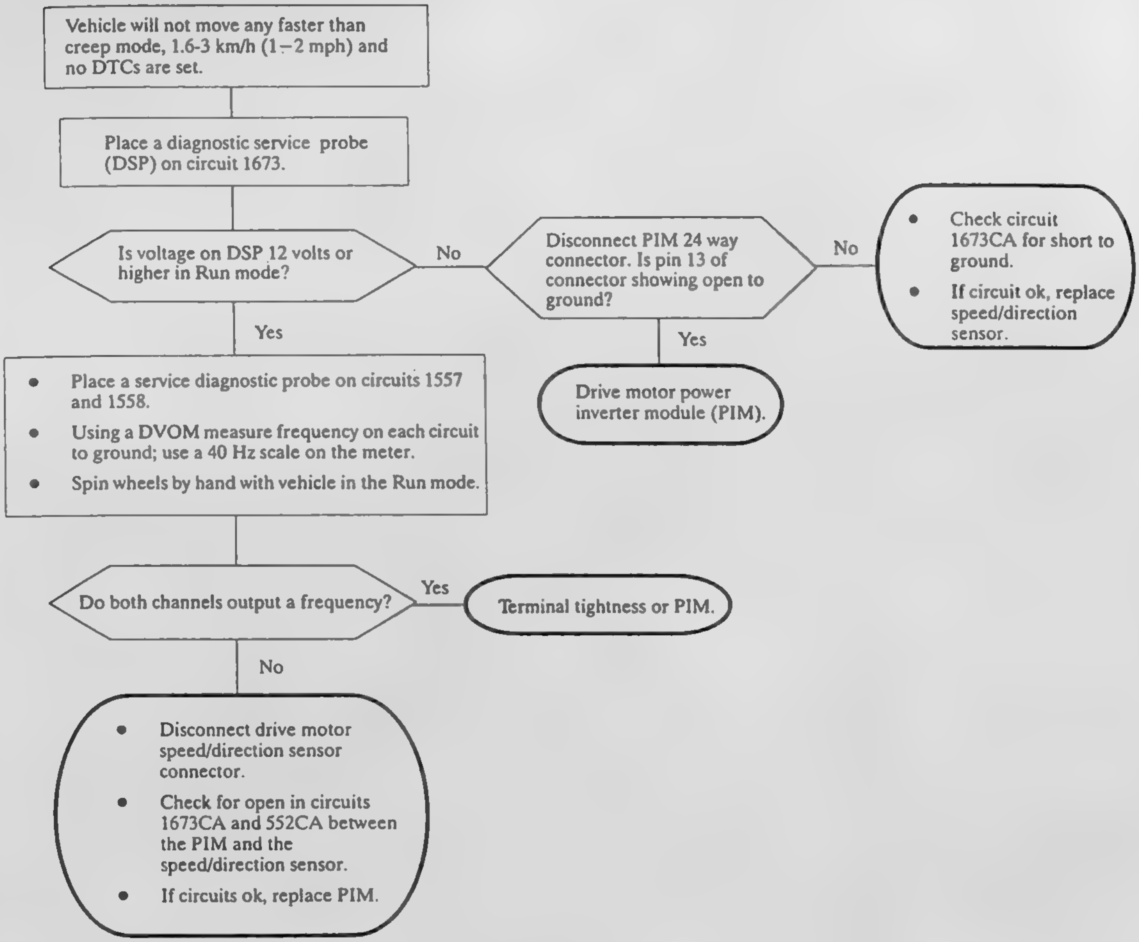
NO DTCS AND VEHICLE WILL NOT MOVE FASTER THAN 1–2 MPH

In order for the drive motor to move, it requires a slip command from the propulsion control module (PCM). The minimum slip value is 0.4 Hz. If no DTCs are set and the vehicle will only move in creep mode regardless of the accelerator input, the PCM is commanding minimum slip. One of the inputs to slip is the speed/direction sensor. If the PCM is not receiving this signal it cannot calculate slip. If one of the signals is lost, the PCM recognizes a problem and sets a code. However, in failure modes where both signals are lost, the PCM has no comparison to detect a problem. Therefore if power, ground or both channel A and B signals are lost no DTCs will be set and no slip command will be sent.

NO DTCS AND VEHICLE WILL NOT MOVE FASTER THAN 1–2 MPH



POWER ELECTRONICS BAY (PEB)

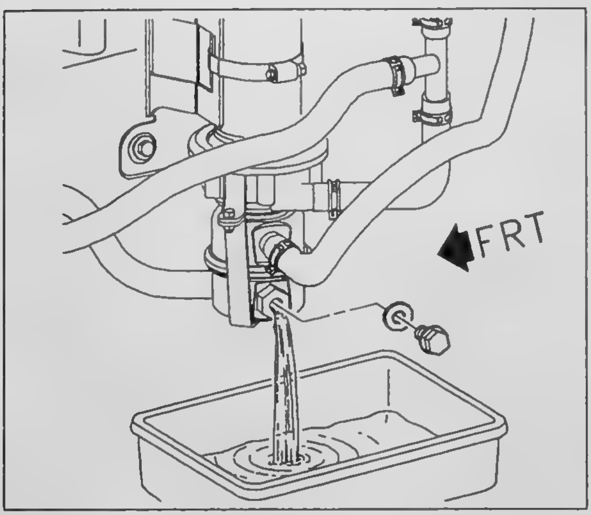
REMOVAL

CAUTION: TO REDUCE THE RISK OF SEVERE SHOCKS AND BURNS, THE HIGH VOLTAGE SYSTEM SHOULD BE DISABLED ANY TIME SERVICE WORK IS BEING PERFORMED ON OR AROUND THE HIGH VOLTAGE SYSTEM. WHEN IN DOUBT, ALWAYS DISABLE THE HIGH VOLTAGE SYSTEM. THE 12 VOLT SYSTEM WILL STILL BE ACTIVE AFTER THE HIGH VOLTAGE SYSTEM HAS BEEN DISABLED.

1. Disable high voltage. (Refer to "High Voltage Disable" in this manual.)
2. Disable 12 volt system. (Refer to "12 Volt System Disable" in this manual.)

IMPORTANT: Do not remove expansion tank cover or open cooling system drains from a hot system. allow system to cool first.

3. Remove the expansion tank cover.
4. Raise the vehicle on a hoist. (Refer to "Lifting, Jacking, and Hoisting" section in this manual.)
5. Remove front underbody air deflector. (Refer to "Front Underbody Air Deflector Removal" procedure in this manual.)
6. Position drain pan under water pump manifold.



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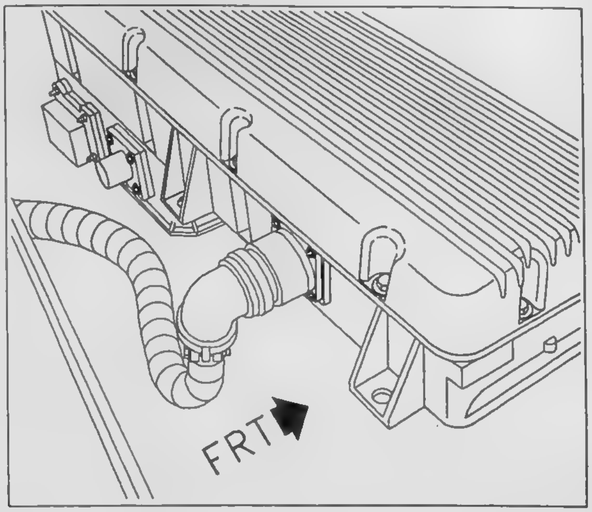
IMPORTANT: A two gallon container will be required to hold the coolant.

7. Remove the drain plug and gasket from the water pump manifold allowing the coolant to flow from the main path.
8. After coolant has drained from the main path, reinstall water pump manifold drain plug and gasket.

Torque: 11 N•m (97 in–lbs)

9. Lower vehicle.

10. Disconnect the battery assembly to power inverter module (PIM) cannon connector from the right rear corner of the PEB.



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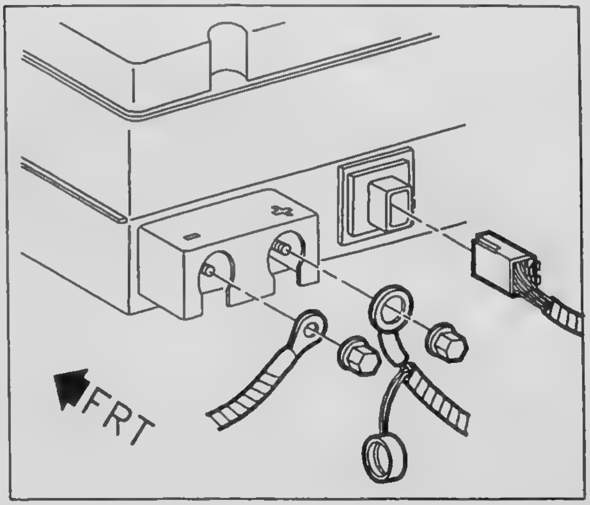
11. Disconnect the accessory AC and DC power control module (APM) 5-way connector from the rear of the PIM.
12. Remove the negative and positive battery cables from the PIM. Voltage should not be present at these connections. If voltage is present verify that all steps of low and high voltage disable have been completed.



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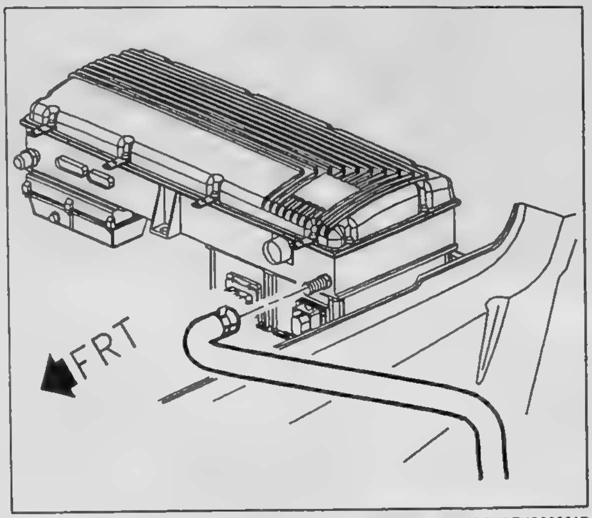
13. Disconnect the driver side coolant hose from the PIM.



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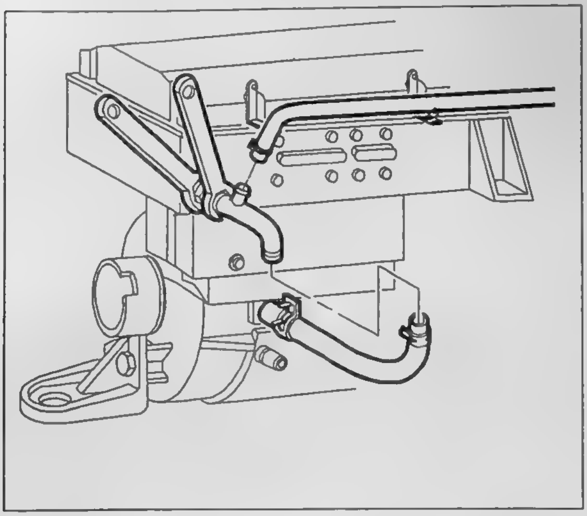
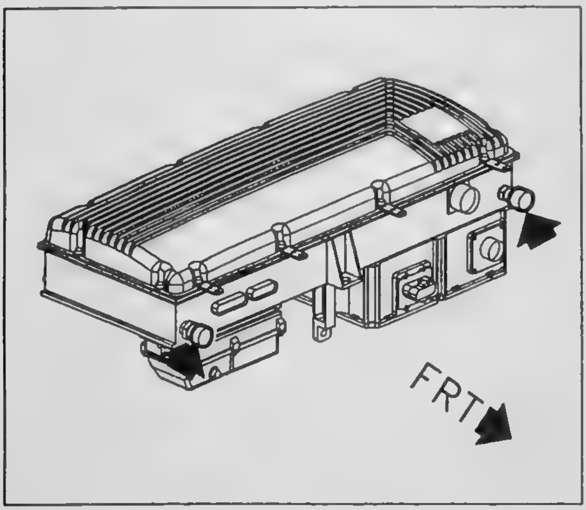


PSMPEN67370AA

NOTICE: Always use a wrench to back up the opposing fitting when disconnecting connections. Failure to use a wrench to back up fittings could cause distortion of connections, fittings or components

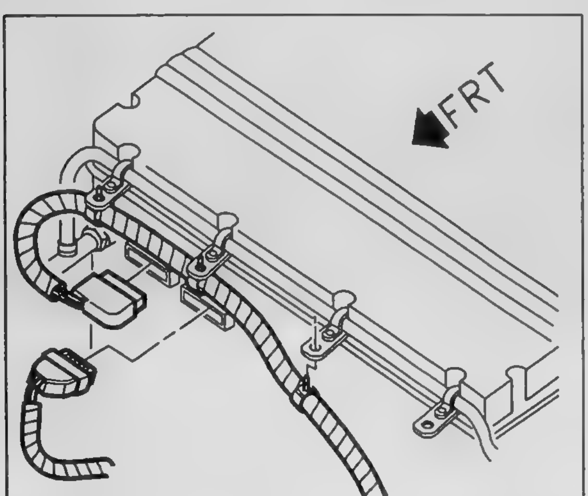
14. Disconnect the passenger side coolant hose from PIM only.



PSMPEN65996AA

15. Install coolant plugs to prevent coolant leakage during removal.

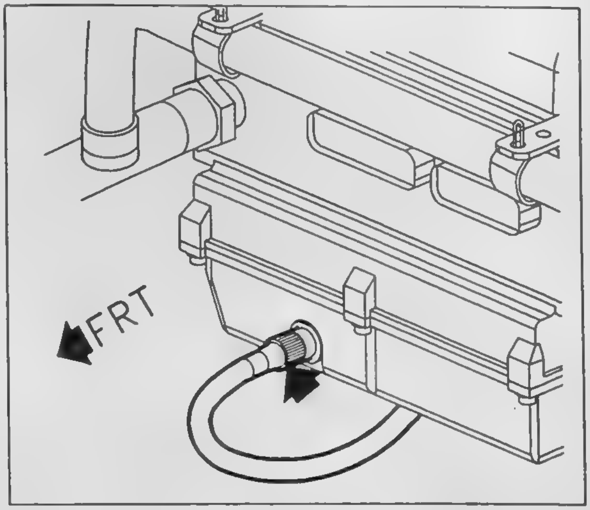
IMPORTANT: If coolant plugs are not available, tape the cooling fittings.



PSMPEN66075AA

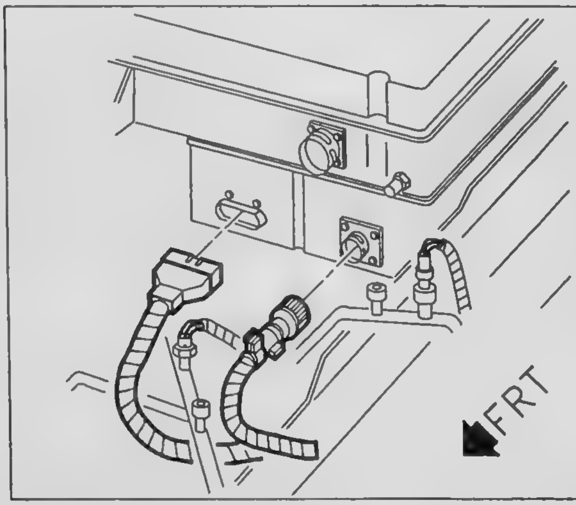
16. Remove the 32-way and the 24-way connectors at the forward right corner of the PIM. To remove the connectors squeeze the connector retainer and pull outward.

17. Disconnect the power steering control module (PSCM) 5-way connector at the PSCM.



PSMPEN66278AA

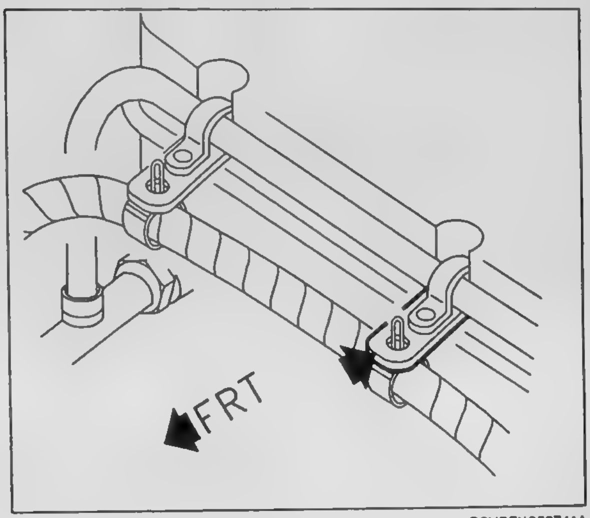
18. Disconnect the accessory AC and DC power control module (APM) 24-way and small cannon connector at the forward left side of the APM.



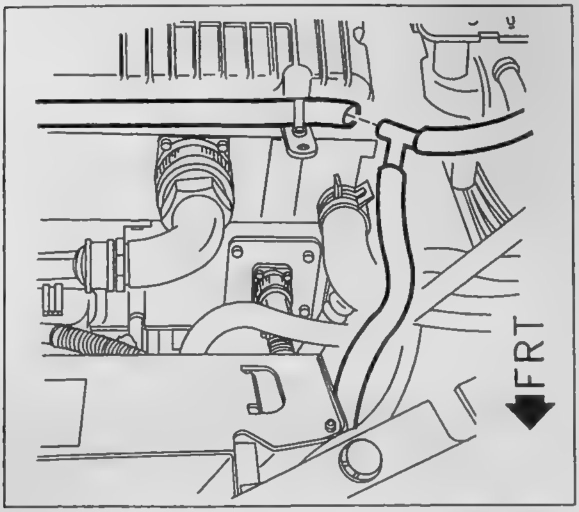
PSMGCH66073AA

IMPORTANT: Do not remove the PIM top cover screws.

19. Remove the wire clips retaining the PEB harness to the front PIM cover brackets and remove the PEB harness away from the PEB.

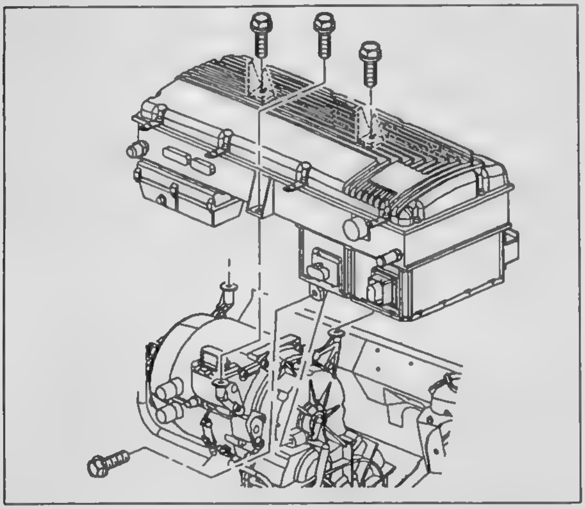


PSMPEN66074AA



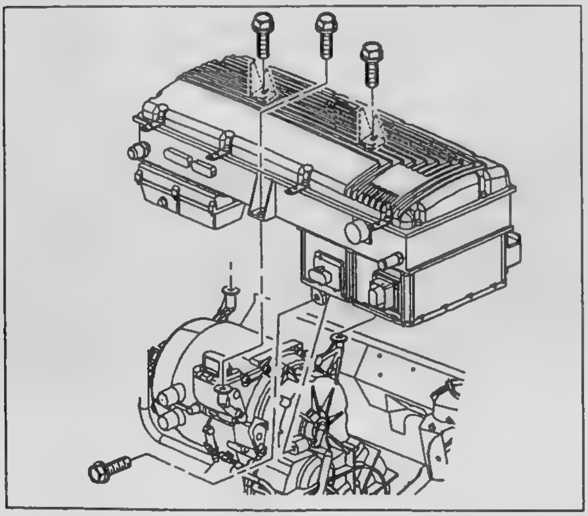
PSMPEN66021AA

20. Remove the coolant hose at the "T" going into the expansion tank.



PSMPEN65834AB

21. Remove the lower PEB to drive unit bolt located just to the right of the PEB center, below the top of the engine strut.
22. Remove the remaining PEB to drive motor bolts.
23. Using two people, one at each end of the PEB lift the assembly straight up disconnecting it from the drive motor and continue lifting until the lower attachment tab clears the front of vehicle. Remove the PEB.



PSMPEN65834AB

INSTALLATION

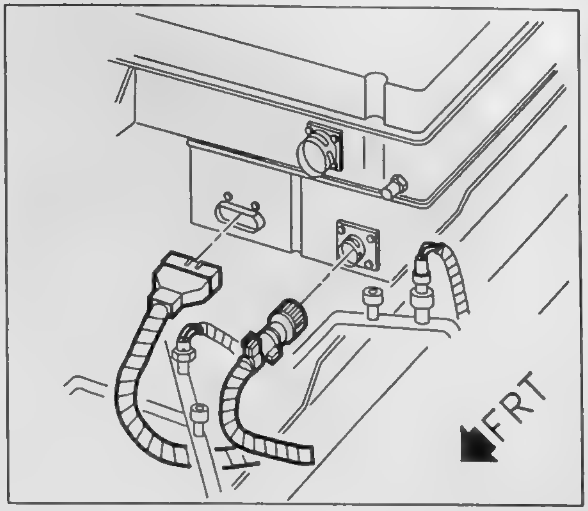
1. Using two people position the PEB over the drive motor connection point. Carefully lower the PEB over the drive motor and into position.
2. Install the top PEB to drive motor bolts. Lightly tighten bolts.
3. Install the lower PEB to drive motor bolt located just to the right of the PEB center, below the top of the engine strut.

Torque: 35 N•m (26 ft–lbs)

4. Torque the top PEB to motor bolts

Torque: 63 N•m (46 ft–lbs)

5. Connect the APM 24-way connector and the APM cannon connector.

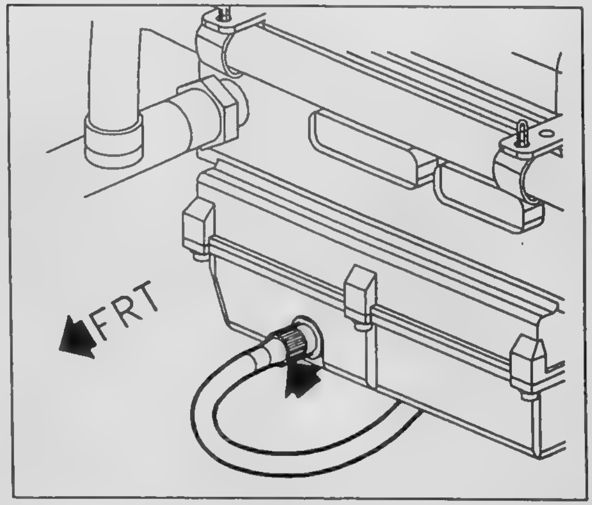


PSMGCH66073AA

6. Connect the PSCM 5-way connector (Yellow cable).

NOTICE: Make sure connector is properly aligned to the connection at the PSCM prior to installation, this will help avoid damaging connector pins.

7. Remove the two PIM coolant plugs.

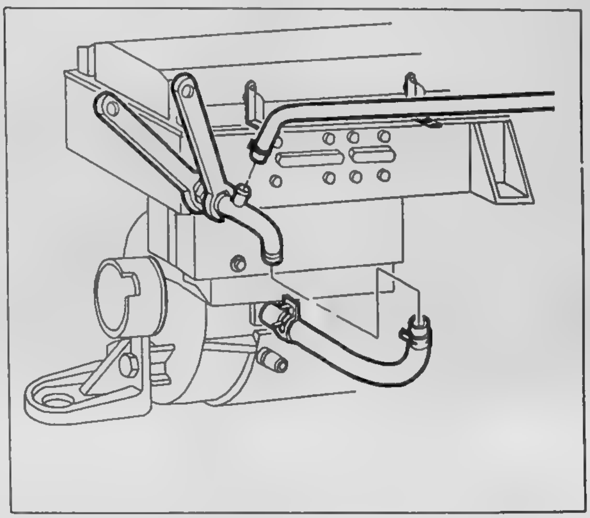


PSMPEN66278AA

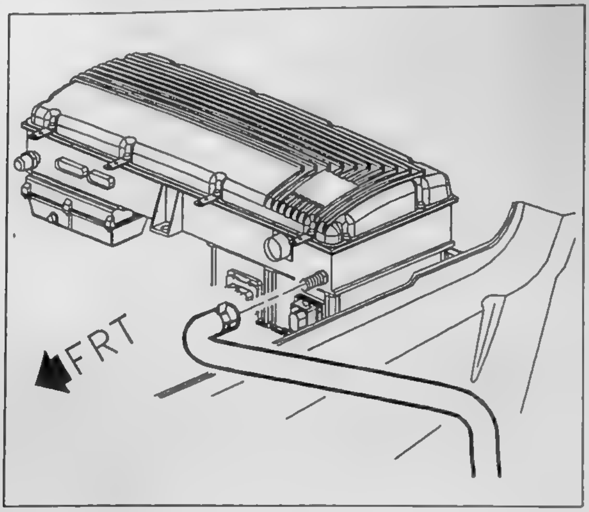
8. Install cooling outlet hose to PIM.

Torque: **100 N•m (74 ft–lbs)**

NOTICE: Always use a wrench to back up the opposing fitting when disconnecting connections. Failure to use a wrench to back up fittings could cause distortion of connections, fittings or components.

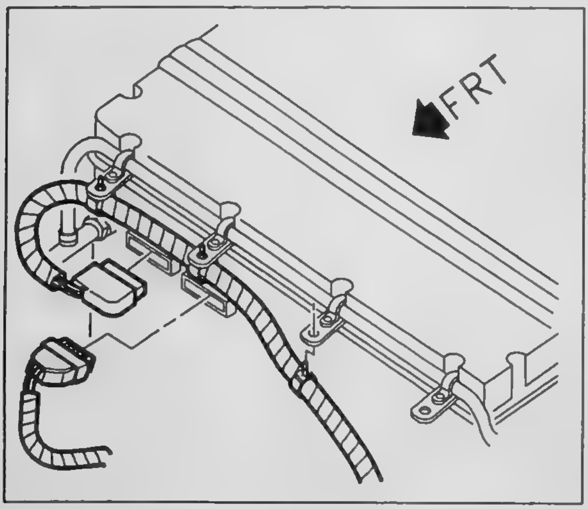


PSMPEN67370AA



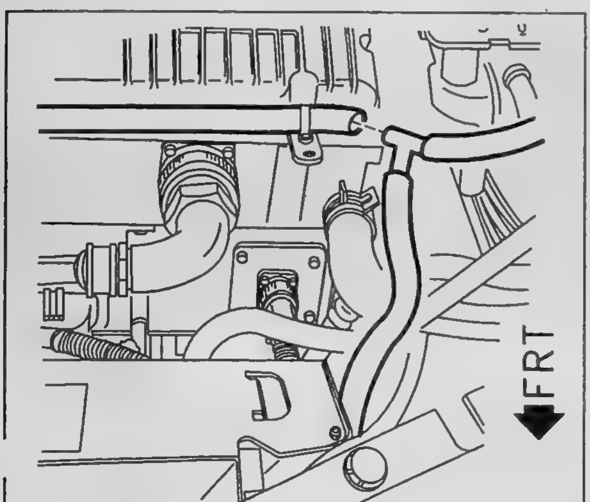
PSMPEN66020AB

9. Install hose and clamp on PIM inlet cooling fitting. Position clamp tangs at 2 o'clock.



PSMPEN66075AA

10. Connect 32-way and the 24-way connectors at the front of the PIM.
11. Install the wire clips to retain PEB harness to the front PIM cover brackets.

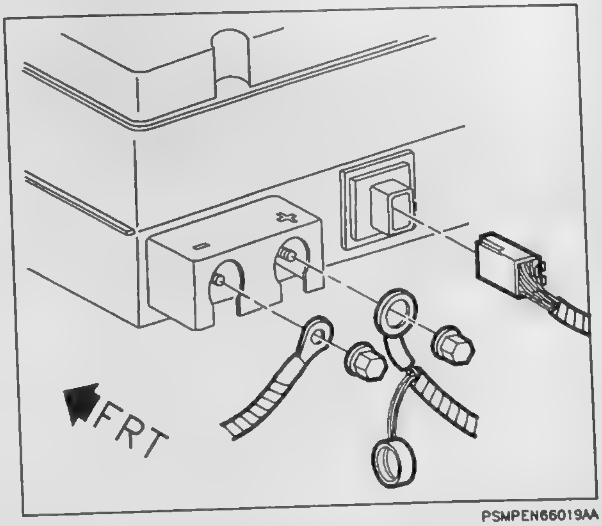


PSMPEN66021AA

12. Install vent hose to vent "T."

13. Connect the APM, 5-way connector at the rear of the APM.
14. Connect the negative and positive battery cables to the left rear of the APM.

Torque: 18 N•m (160 in–lbs)

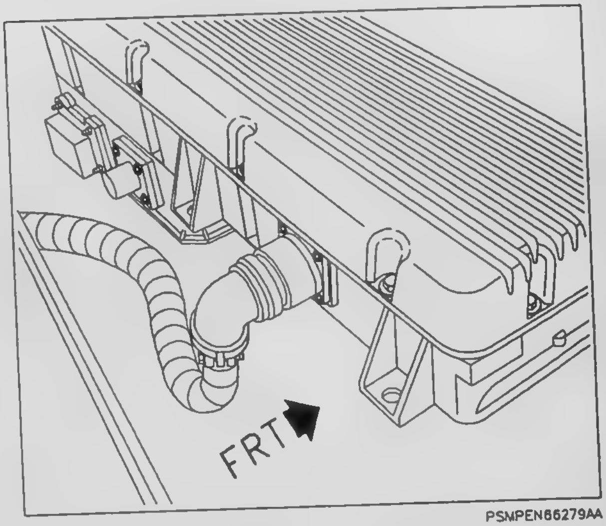


PSMPEN66019AA

15. Connect battery assembly pack cannon connector to right rear corner of the PIM. Tighten connector until indicator marks line-up.

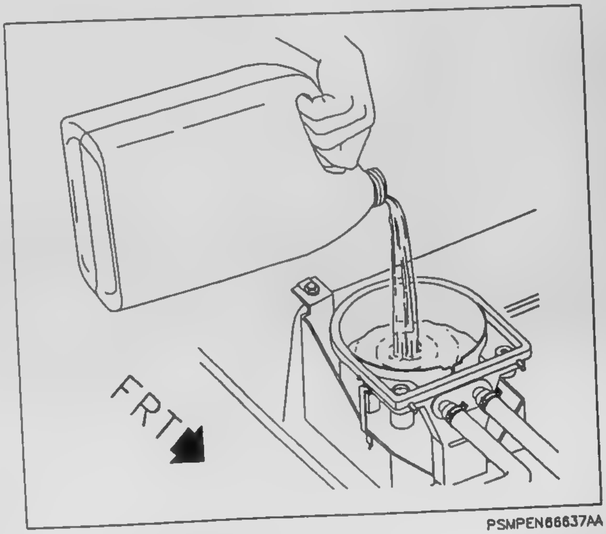
NOTICE: Do not use any tools to reinstall the connector. Excessive force or misalignment can damage the connector pins.

16. Enable high voltage. (Refer to "High Voltage Enable" in this manual.)

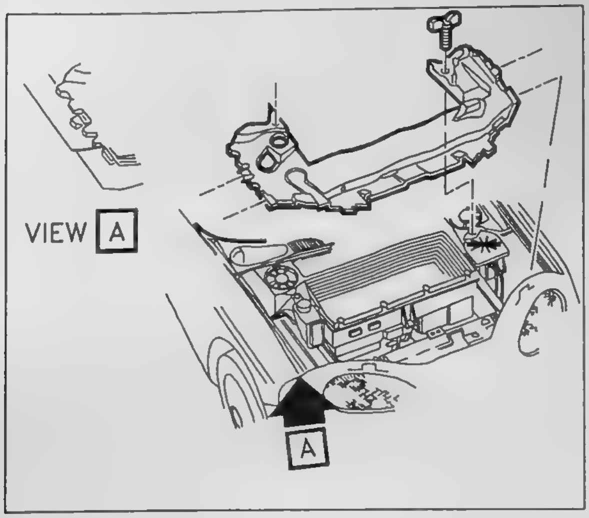


PSMPEN66279AA

17. Check to insure that all the hoses and fittings are connected.
18. Fill coolant system until you reach the fill line on the expansion tank with GMEV coolant part 27002485 or equivalent which meets GM spec #9986100. The fluid level will drain down into the coolant system slowly and fluid should be added until the fluid level stabilizes.
19. Place vehicle in run mode. If vehicle does not power-up, refer to the "High Voltage" section of the service manual.
20. Maintain fluid level to fill line in expansion tank.
    a. After one minute turn on heat mode. Maintain fluid level to fill line in expansion tank.
    b. After one minute turn on vent mode.



PSMPEN66637AA

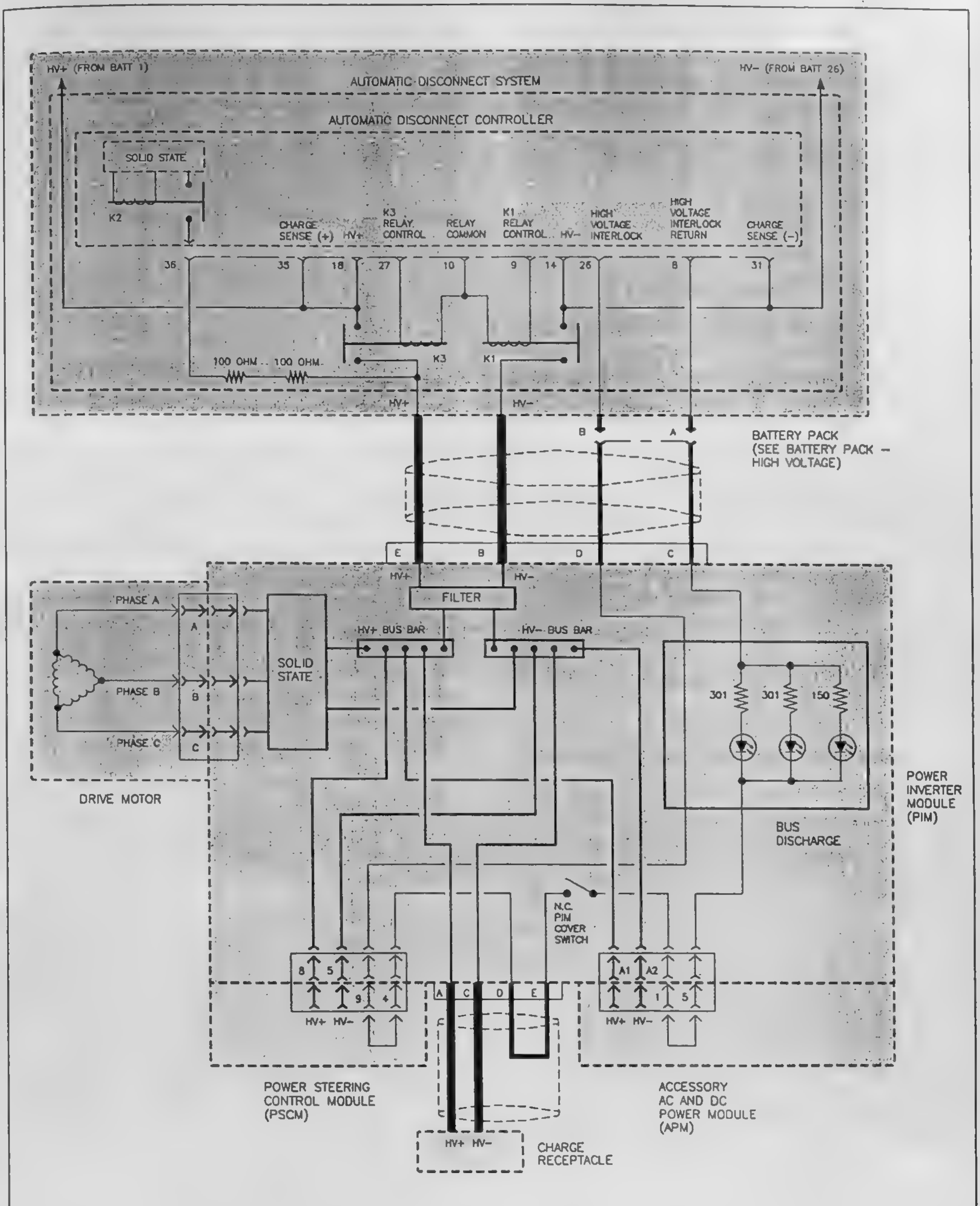


PSMGEP65869AC

21. Repeat previous step two more times.
22. After one minute turn on heat mode.
23. Insert charger paddle into charger receptacle. Verify charger is operating.
24. Maintain fluid level to fill line in expansion tank.
25. After one minute remove charger paddle from charger receptacle.
26. Turn HVAC system to vent mode.
27. Insert charger paddle into charger receptacle. Verify charger is operating.
28. After two minutes remove charger paddle from charger receptacle. Top off fluid level to fill line, install cover on expansion tank and check for leaks.
29. Install engine compartment sight shield.
30. Clear all DTCs using PDT.
31. Raise vehicle on hoist.
32. Install front underbody air deflector. (Refer to "Front Underbody Air Deflector Installation" procedure in this manual.)

IMPORTANT: If the PIM has been replaced, the PCM must be reprogrammed.

PROPULSION (HIGH VOLTAGE)



PSMELC67643AD

PIM AND DRIVE MOTOR TEMPERATURE SENSORS

The PIM provides a thermal interface to transfer waste thermal energy generated by the PIM, APM, and PSCM to the cooling fluid. The PIM transfers heat through the cold-plate, located within the PEB, into the thermal and climate control subsystem for dissipation. Drive motor temperature information is used by the PCM to determine drive motor slip and by the HTCM for thermal control.

The PIM has a cold plate temperature sensor located on the cold-plate. The cold-plate temperature sensor is a thermistor-type sensor. As the temperature drops the resistance of the thermistor increases and as the temperature increases the resistance decreases. The table below shows temperature vs resistance for the cold-plate sensor. If the sensor reading exceeds 74 degrees the PCM code 34 is set (PEB temperature out of range) and the Service Soon telltale is illuminated. If the sensor or sensor circuits are open or shorted to ground, PCM codes 1 or 2 will be set and the Service Soon telltale will be turned On.

PIM COLD PLATE TEMPERATURE SENSOR TEMPERATURE VS RESISTANCE CHART

TEMP IN °C (°F)	NOMINAL RESISTANCE	TEMP IN °C (°F)	NOMINAL RESISTANCE
−40 (−40)	336,500	60 (140)	2,488
−30 (−22)	177,000	70 (158)	1,752
−20 (−4)	97,070	80 (176)	1,258
−10 (14)	55,330	90 (194)	918
0 (32)	32,650	100 (212)	680
10 (50)	19,900	110 (230)	511
20 (68)	12,490	120 (248)	389
25 (77)	10,000	130 (266)	301
30 (86)	8,057	140 (284)	235
40 (104)	5,327	150 (302)	185
50 (122)	3,603		

DRIVE MOTOR TEMPERATURE SENSORS

The drive motor has two temperature sensors. One sensor is laminated into the stator windings of the motor and the other is located in the coolant passage of the drive motor. The drive motor temperature sensor located in the stator windings is used by the PCM to monitor motor stator temperature. The drive motor coolant temperature sensor is used by the HTCM to monitor overall motor and final drive assembly temperature.

MOTOR STATOR TEMPERATURE SENSOR

The motor stator temperature sensor operates on a 12 volt DC signal provided by the PCM. As the stator temperature increases the resistance of the sensor decreases and as the stator temperature decreases the resistance of the sensor increases. This information is contained in a table allowing the PCM to determine if the temperature is in an acceptable temperature range. The motor stator temperature sensor is not replaceable except with and entire drive motor assembly. If the PCM determines that the temperature is over 165°C (329°F), DTC 376 is set and the TEMP telltales is illuminated. If the temperature exceeds 170°C (338°F) the Reduced Performance telltale is turned On and the vehicle enters the reduced performance mode. Once the temperature drops below 160°C the telltales are turned Off.

MOTOR STATOR TEMPERATURE SENSOR TEMPERATURE VS RESISTANCE CHART

TEMP IN °C (°F) (±4°C)	RESISTANCE (OHMS)	TEMP IN °C (°F) (±8°C)	RESISTANCE (OHMS)
−20 (−4)	936K	100 (212)	6861
0 (32)	320K	120 (248)	3907
20 (68)	125K	140 (284)	2337
40 (104)	54K	160 (320)	1456
60 (140)	25K	180 (356)	943
80 (176)	12.7K		

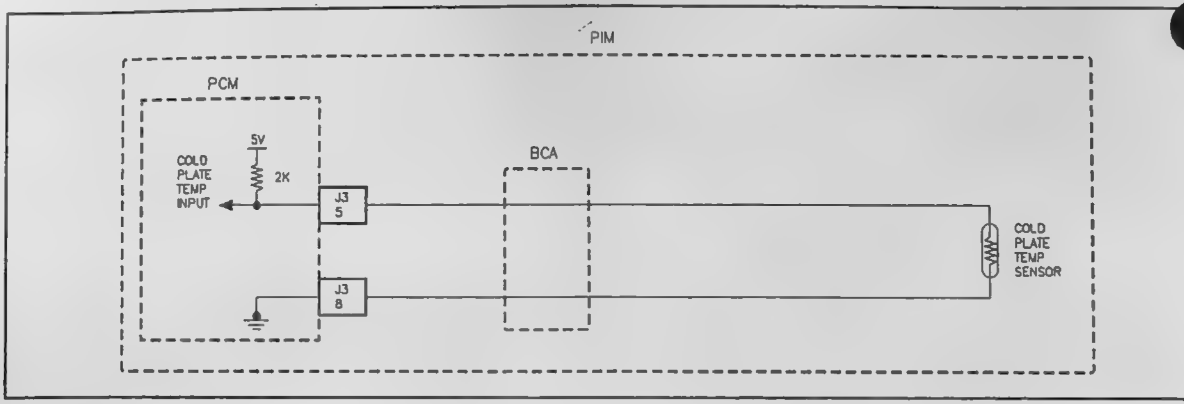
DRIVE MOTOR COOLANT TEMPERATURE SENSOR

The drive motor coolant temperature sensor is located in the coolant passage of the motor assembly and operates on a 12 volt input from the HTCM. As the coolant temperature increases the resistance of the coolant temperature sensor decreases and as the coolant temperature decreases the resistance increases. If the HTCM determines the temperature exceeds 93°C (200°F) it sets an HTCM code 48. This sensor input is not used by the HTCM.

DRIVE MOTOR COOLANT TEMPERATURE SENSOR

TEMP IN °C (°F)	RESISTANCE (OHMS)	TEMP IN °C (°F)	RESISTANCE (OHMS)
−40 (−40)	73,500 to 128,000	80 (176)	300 to 360
−20 (14)	21,900 to 35,500	100 (230)	160 to 190
0 (32)	7,500 to 11,400	140 (284)	54 to 66
20 (68)	3,100 to 3,900		
50 (122)	880 to 1,100		

DTC 001 – PIM TEMPERATURE SENSOR SHORTED TO GROUND



PSMELC67649AB

PIM TEMPERATURE SENSOR SHORTED TO GROUND

The power inverter module (PIM) temperature sensor is a thermistor which senses the inverter cold-plate temperature. The propulsion control module (PCM) applies a five volt reference to a voltage divider made up of an internal resistor and the cold plate temperature sensor and watches the feedback from the divider. This voltage is converted to a temperature value by the PCM. The temperature sensor is part of the PIM assembly.

DTC PARAMETERS

The DTC will set any time the temperature sensor is shorted to ground (voltage is less than 0.16 volts for 10 seconds).

ACTION TAKEN BY PCM

The SERVICE SOON telltale will be illuminated and the DTC will be stored. The PCM will send a default temperature to the HPVS/thermal control module (HTCM) and display the default temperature in serial data. If the fault is intermittent and clears itself, the telltale will turn off after 10 seconds.

RELATED DTCS

None

TELLTALE ILLUMINATED:

SERVICE SOON

DIAGNOSTIC AIDS

- Refer to Description and operation for temperature vs. Ohm reading table.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- The HTCM uses this temperature value for PEB cooling.
- The PCM will send out a default value of −39.75°C (−39.55F).

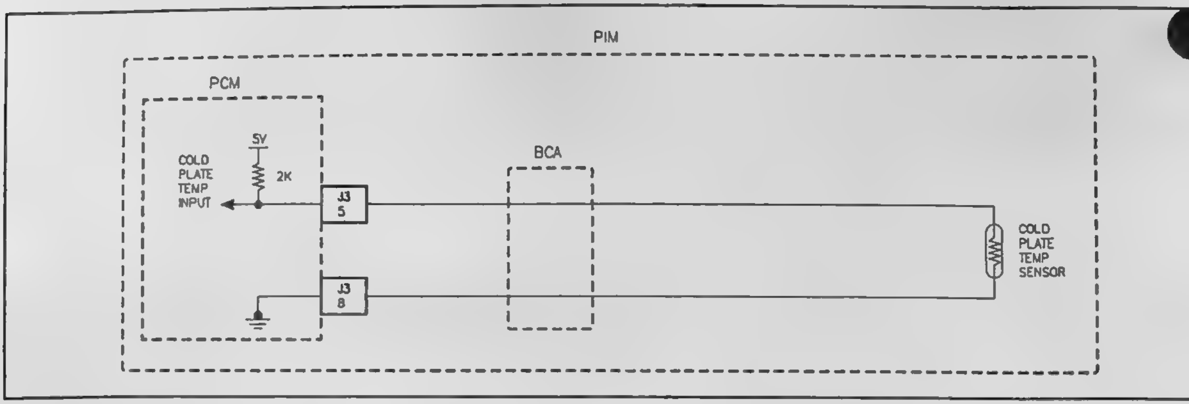
* Select Malfunction History from the Scan tool PCM menu.

DTC 001
PIM TEMPERATURE SENSOR SHORTED TO GROUND

If DTC 001 is set it is due to an internal PIM fault.

Replace PIM.

DTC 002 – PIM TEMPERATURE SENSOR OPEN OR SHORTED TO VOLTAGE



PSMELC67649AB

PEB TEMPERATURE SENSOR OPEN OR SHORTED TO VOLTAGE

The power inverter module (PIM) temperature sensor is a thermistor which senses the inverter cold-plate temperature. The propulsion control module (PCM) applies a five volt reference to a voltage divider made up of an internal resistor and the cold plate temperature sensor and watches the feedback from the divider. This voltage is converted to a temperature value by the PCM. The temperature sensor is part of the PIM assembly.

DTC PARAMETERS

The DTC will set any time the temperature sensor is open or shorted to battery (voltage is greater than 4.92 volts for 10 seconds).

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC will be stored. The PCM will send a default temperature to the HPVS/thermal control module (HTCM) and display the default temperature in serial data.

If the fault is intermittent and clears itself, the telltale will turn Off after 10 seconds.

RELATED DTCS

None

TELLTALE ILLUMINATED:

SERVICE SOON

DIAGNOSTIC AIDS

- Refer to Description and operation for temperature vs. Ohm reading table.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- The HTCM uses this temperature value for PEB cooling.
- The PCM will send out default value of −39.75°C (−39.55°F).

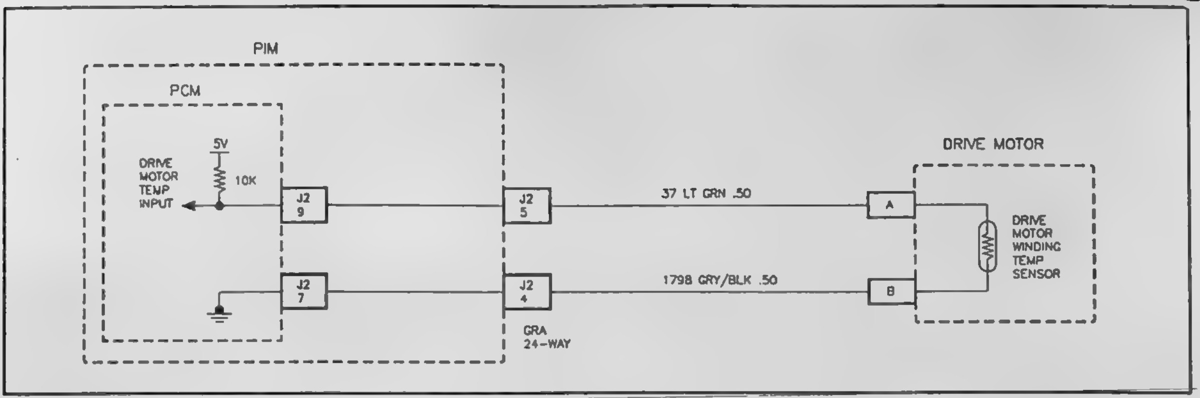
* Select Malfunction History from the Scan tool PCM menu.

DTC 002
PIM TEMPERATURE SENSOR OPEN OR SHORTED TO VOLTAGE

If DTC 002 is set it is due to an internal PIM fault.

Replace PIM.

DTC 003 – MOTOR STATOR WINDING TEMPERATURE SENSOR SHORTED TO GROUND



PSMELC67650AB

MOTOR STATOR WINDING TEMPERATURE SENSOR SHORTED TO GROUND

The motor stator winding temperature sensor is a thermistor which senses the motor winding temperature. The propulsion control module (PCM) applies a 5 volt reference to a voltage divider made up of an internal resistor and motor stator winding temperature sensor, and watches the feedback from the divider. This voltage is converted to a temperature value by the PCM. The motor stator winding temperature sensor is located within the windings of the motor and is not serviceable.

DTC PARAMETERS

The DTC will set any time the temperature sensor is shorted to ground (voltage is less than 0.25 volts for 10 seconds).

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC will be stored. The PCM will substitute a default temperature for internal processing and will display the default in place of the actual sensor valve on serial data. If the fault is intermittent and clears itself, the telltale will turn Off after 10 seconds and the PCM will return to normal operation.

TELLTALE ILLUMINATED:

SERVICE SOON

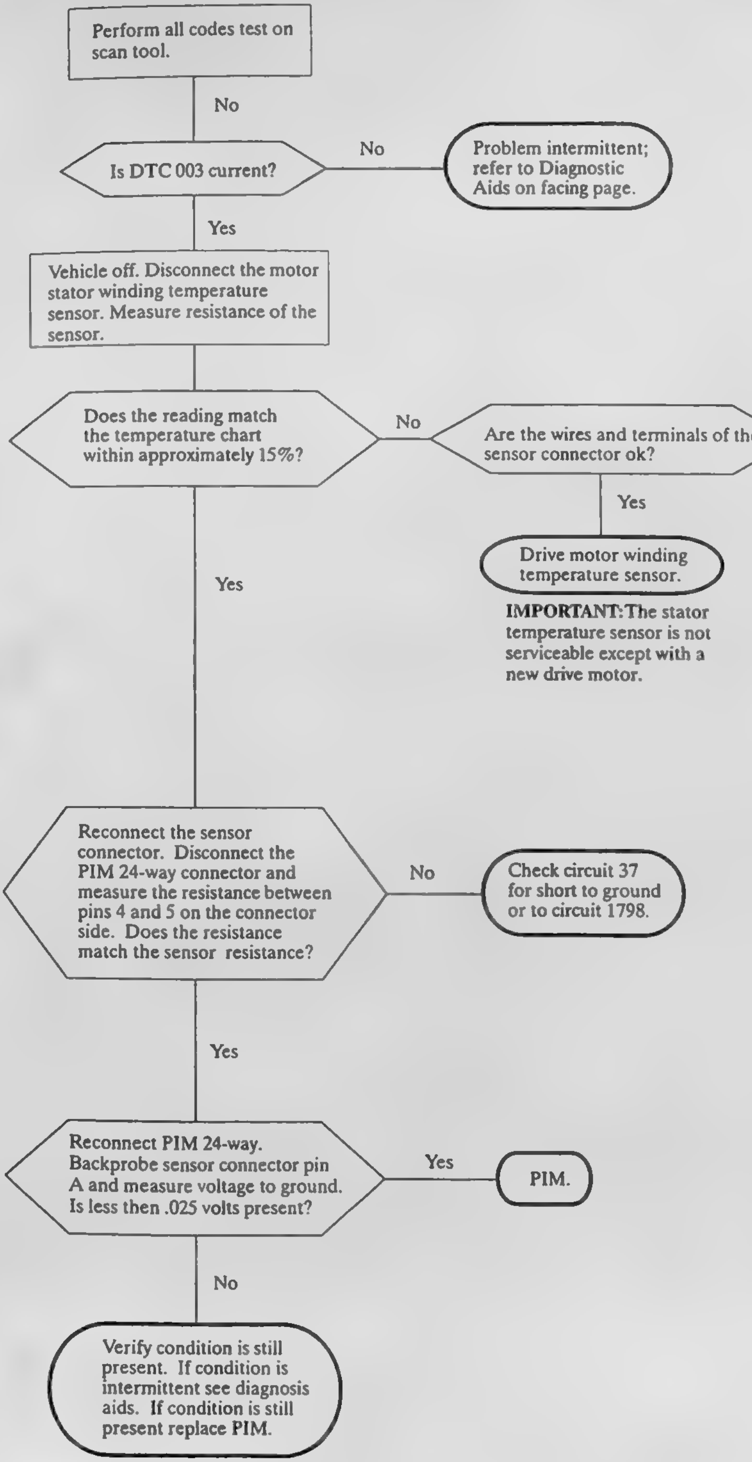
DIAGNOSTIC AIDS

- Refer to DTC chart for temperature vs. Ohm reading table.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.
- When the DTC sets, the PCM defaults to 30°C (86°F). The Scan tool will read the default value.

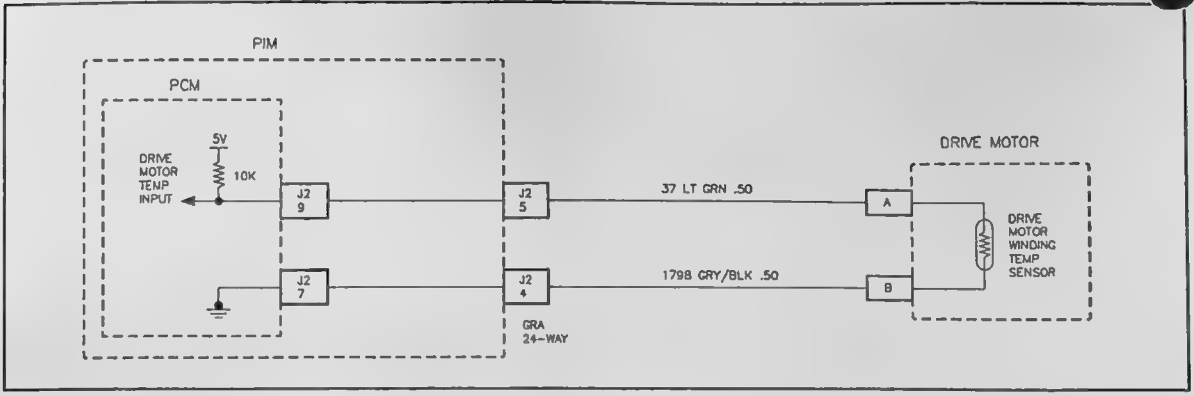
DTC 003
MOTOR STATOR WINDING TEMPERATURE SENSOR SHORTED TO GROUND



TEMPERATURE CHART

Temperature in °C (°F)	Resistance Ohms (±15%)
-20 (−4)	936K
-10 (14)	539K
0 (32)	320k
10 (50)	197k
20 (68)	125k
30 (86)	80k
40 (104)	54k
50 (122)	36k
60 (140)	25k
70 (158)	18k
80 (176)	12.7k
90 (194)	9284
100 (212)	6861
110 (230)	5143
120 (248)	3907
140 (284)	2337
160 (320)	1456
180 (356)	943
200 (392)	633

DTC 004 – MOTOR STATOR WINDING TEMPERATURE SENSOR OPEN OR SHORTED TO VOLTAGE



PSMELC67650AB

MOTOR STATOR WINDING TEMPERATURE SENSOR OPEN OR SHORTED TO VOLTAGE

The motor stator winding temperature sensor is a thermistor which senses the motor winding temperature. The propulsion control module (PCM) applies a 5 volt reference to a voltage divider made up of an internal resistor and motor stator winding temperature sensor, and watches the feedback from the divider. This voltage is converted to a temperature value by the PCM. The motor stator winding temperature sensor is located within the windings of the motor and is not serviceable.

DTC PARAMETERS

The DTC will set any time the temperature sensor is open or shorted to voltage (voltage is greater than 4.92 volts) for 10 seconds.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC will be stored. The PCM will substitute a default temperature for internal processing and will display the default in place of the actual sensor value in serial data. If the fault is intermittent and clears itself, the telltale will turn off after 10 seconds.

TELLTALE ILLUMINATED:

SERVICE SOON

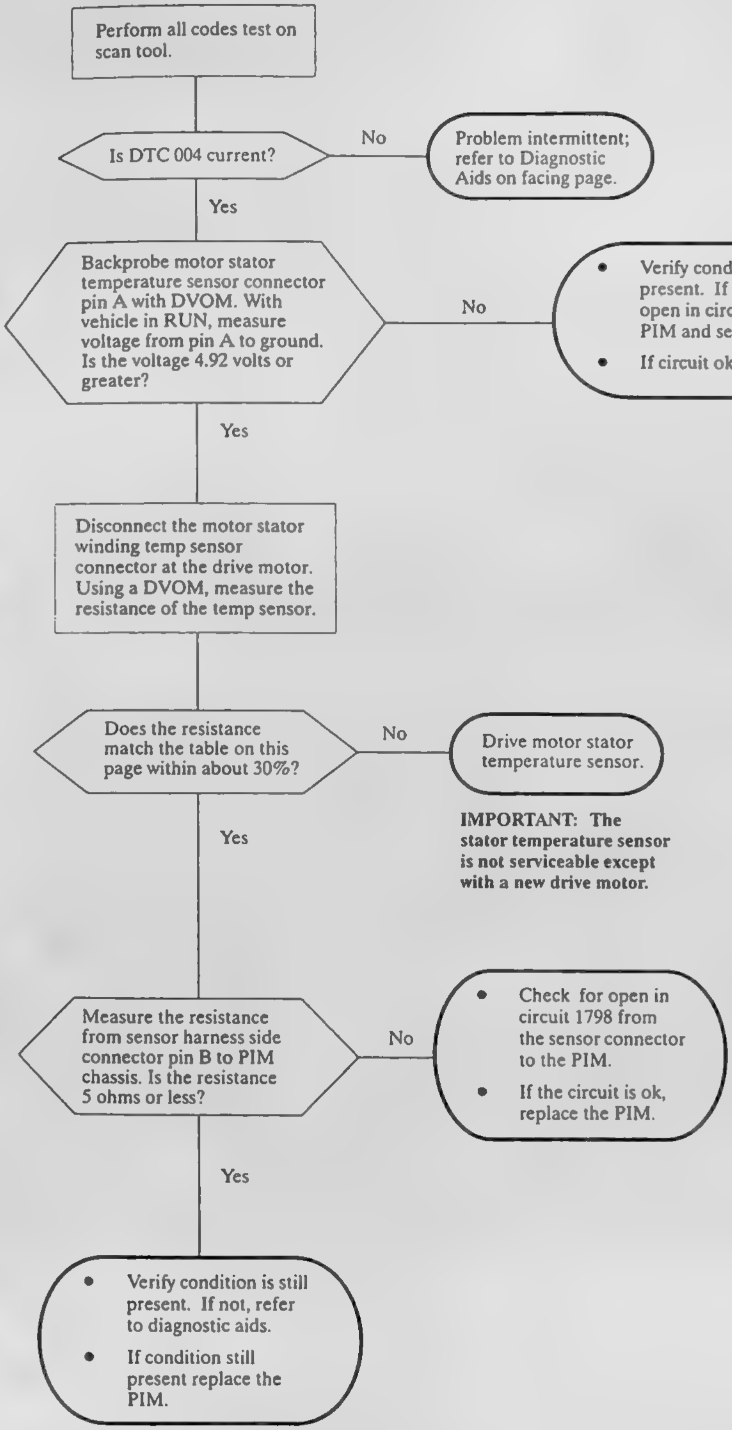
DIAGNOSTIC AIDS

- Refer to DTC chart for temperature vs. Ohm reading table.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.
- When the DTC sets, the PCM defaults to 30°C (86°F). The Scan tool will read the default value.

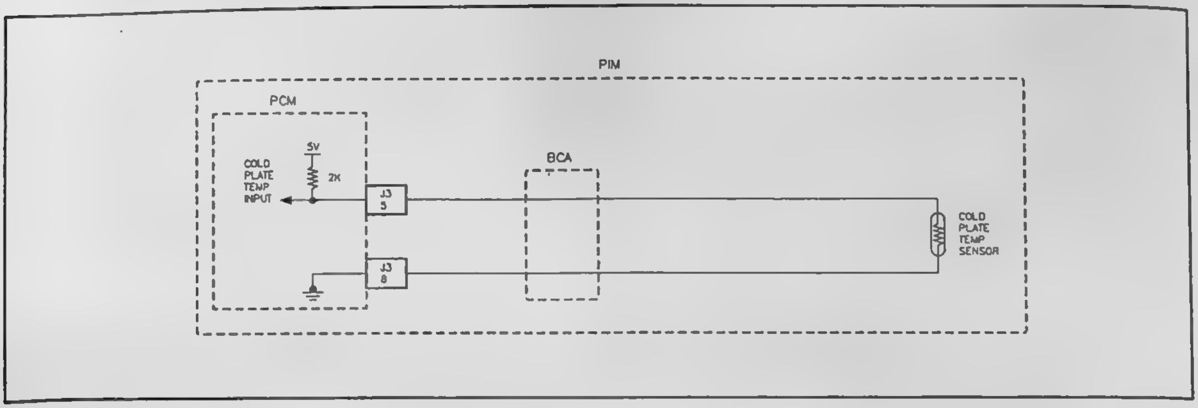
DTC 004
MOTOR STATOR WINDING TEMPERATURE SENSOR OPEN OR SHORTED TO VOLTAGE



TEMPERATURE CHART

Temperature °0C (°0F)	Resistance Ohms
-20 (−4)	936K
-10 (14)	539K
0 (32)	320k
10 (50)	197k
20 (68)	125k
30 (86)	80k
40 (104)	54k
50 (122)	36k
60 (140)	25k
70 (150)	18k
80 (176)	12.7k
90 (194)	9284
100 (212)	6861
110 (230)	5143
120 (248)	3907
140 (284)	2337
160 (320)	1456
180 (356)	943
200 (392)	633

DTC 034 – PIM TEMPERATURE OUT OF RANGE



PSMELC67649AB

PIM TEMPERATURE OUT OF RANGE

The motor stator winding temperature sensor is a thermistor which senses the motor winding temperature. The propulsion control module (PCM) applies a 5 volt reference to a voltage divider made up of an internal resistor and motor stator winding temperature sensor, and watches the feedback from the divider. This voltage is converted to a temperature value by the PCM. The motor stator winding temperature sensor is located within the windings of the motor and is not serviceable.

DTC PARAMETERS

The DTC will set any time the temperature sensor reads over 74 degrees Celsius.

ACTION TAKEN BY THE PCM

The REDUCED PERFORMANCE AND TEMPERATURE telltale will be illuminated and the DTC will be stored. If fault clear, the temperature telltale will turn off after 10 seconds. Reduced performance telltale and reduced performance mode will be cleared on next ignition cycle

RELATED DTCS

HTCM 17, 46, 47, 48, 49, and PCM 37.

TELLTALE ILLUMINATED:

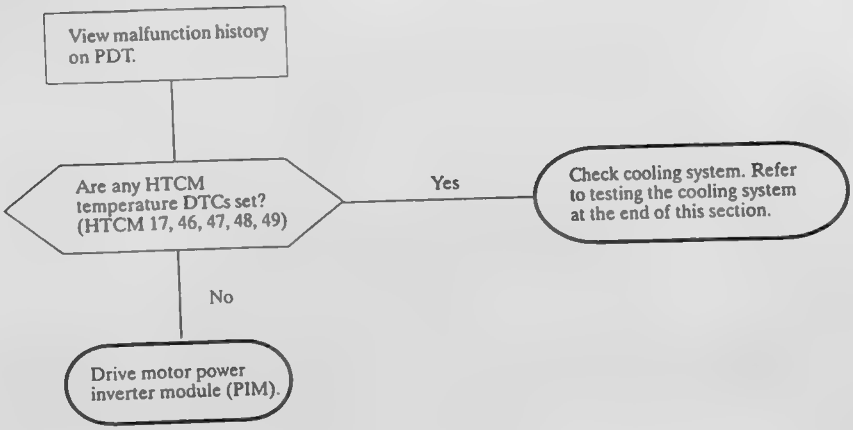
REDUCED PERFORMANCE AND TEMPERATURE

DIAGNOSTIC AIDS

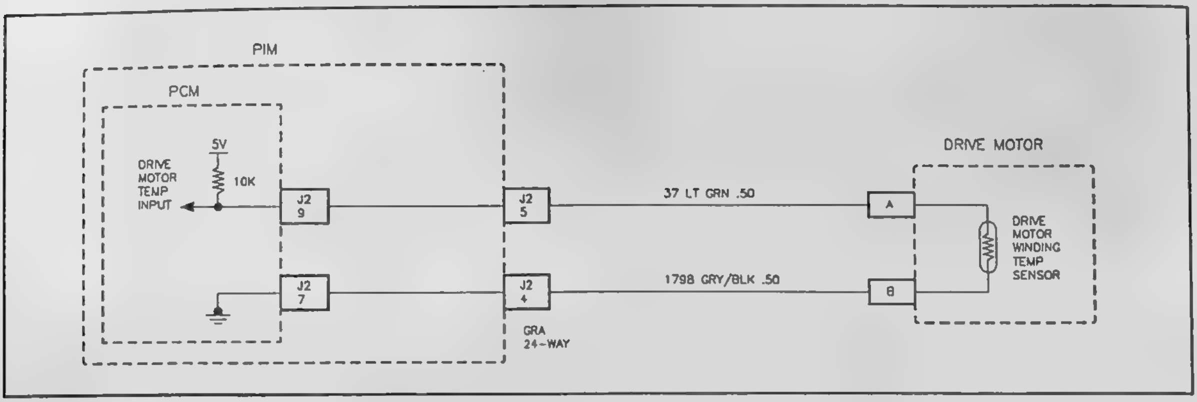
- Refer to DTC chart for temperature vs. Ohm reading table.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when thc DTC set.
- Check for other temperature DTCs. If present, check out the cooling system operation.

* Select Malfunction History from the Scan tool PCM menu.

DTC 034
PIM TEMPERATURE OUT OF RANGE



DTC 037 – DRIVE MOTOR STATOR WINDING OVER HEAT CONDITION



PSMELC67650AB

DRIVE MOTOR STATOR WINDING OVER HEAT CONDITION

The motor stator winding temperature sensor is a thermistor which senses the motor winding temperature. The propulsion control module (PCM) applies a 5 volt reference to a voltage divider made up of an internal resistor and motor stator winding temperature sensor, and watches the feedback from the divider. This voltage is converted to a temperature value by the PCM. The motor stator winding temperature sensor is located within the windings of the motor and is not serviceable.

DTC PARAMETERS

The DTC will set when the motor winding temperature exceeds 165 degrees C.

ACTION TAKEN BY THE PCM

A DTC is stored, and the TEMP (temperature) telltale is turned On. If the temperature of motor winding drops below 160°C (320°F), the TEMP telltale is turned Off.

At 170°C (338°F), the Reduced Performance telltale is turned On and the vehicle enters reduced performance mode. The vehicle stays in reduced performance for the remainder of the ignition cycle.

RELATED DTCS

HTCM 17, 46, 47, 48, 49, PCM 36

TELLTALE ILLUMINATED:

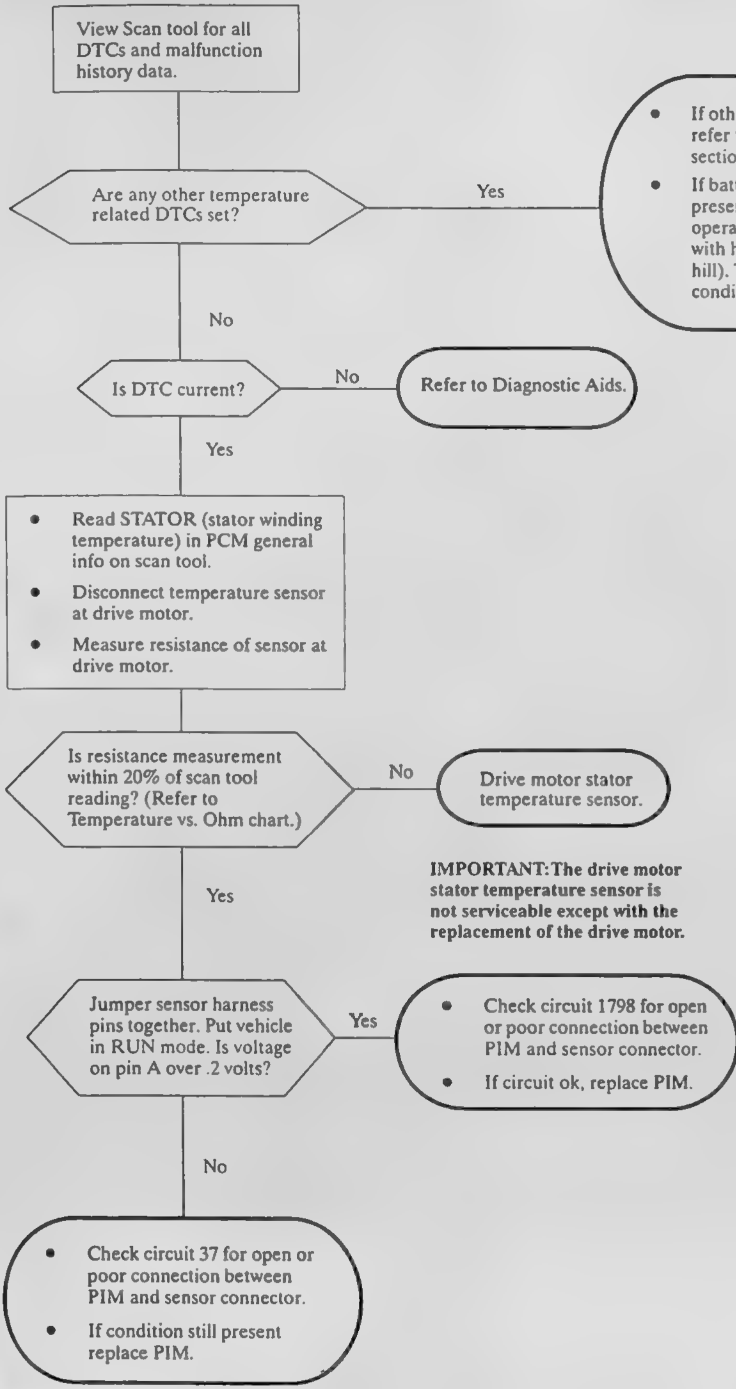
TEMP (at 165°C) and REDUCED PERFORMANCE (at 170°C).

DIAGNOSTIC AIDS

- This DTC may set under very high ambient temperatures (over 100°F) if the vehicle is driven aggressively. This is a normal condition. Use the Malfunction history data to determine conditions when DTC set.
- After overnight soak the temperatures of all temperature sensors should be within four degrees Celsius.
- Refer to DTC chart for temperature vs. Ohm reading table.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

* Select Malfunction History from the Scan tool PCM menu.

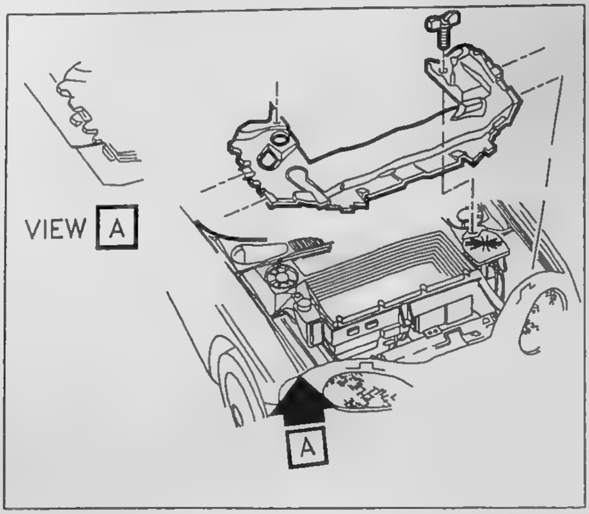
DTC 037
DRIVE MOTOR STATOR WINDING OVER HEAT CONDITION



IMPORTANT: The drive motor stator temperature sensor is not serviceable except with the replacement of the drive motor.

TEMPERATURE CHART

Temperature in °C (°F)	Resistance Ohms
-20 (−4)	936K
-10 (14)	539K
0 (32)	320k
10 (50)	197k
20 (68)	125k
30 (86)	80k
40 (104)	54k
50 (122)	36k
60 (140)	25k
70 (158)	18k
80 (176)	12.7k
90 (194)	9284
100 (212)	6861
110 (230)	5143
120 (248)	3907
140 (284)	2337
160 (320)	1456
180 (356)	943
200 (392)	633

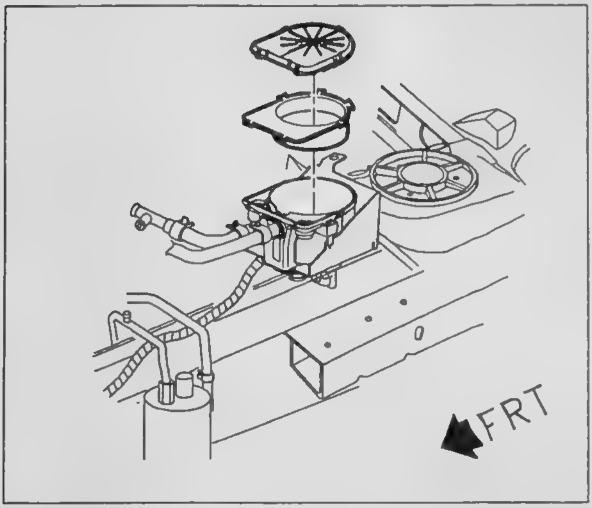


PSMGEP65869AC

TESTING THE COOLANT SYSTEM

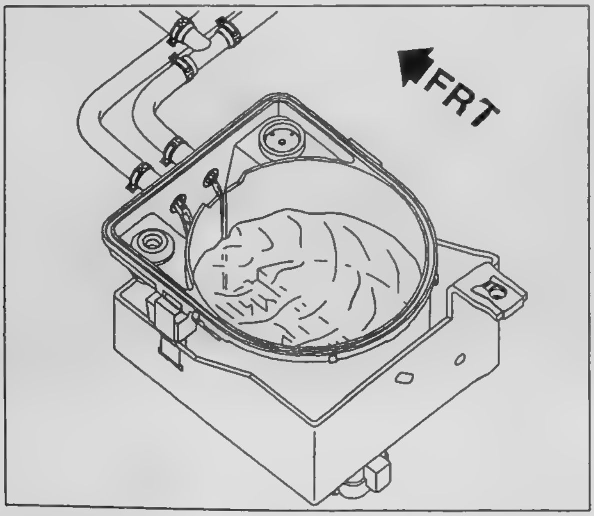
OPERATIONAL TEST

1. Remove engine compartment sight shield.



PSMPEN66720AA

2. Remove expansion tank cover.
3. Place vehicle in RUN mode with heater system in the Off mode. Vehicle not charging.



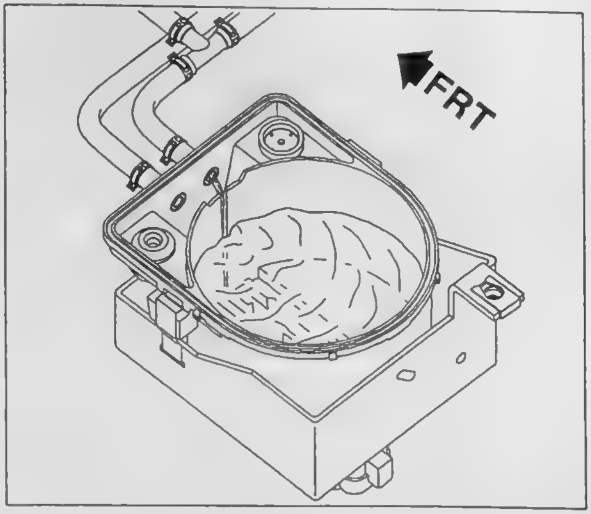
PSMPEN67367AA

Coolant should be flowing from both vent hoses into the expansion tank. The radiator vent hose on the left side will have a higher volume (thicker) stream as compared to the vent hose on the right. The pressure of the two coolant streams coming into the expansion tank should be about equal. This will indicate that both coolant valves are closed and coolant is being sent through the radiator.

4. Pump voltage can be monitored with the PDT or service stall while performing this test, the pump voltage will vary depending on the coolant temperature.
5. Coolant recovery check valve and drive motor charger receptacle valve can be monitored with the PDT or service stall while performing this test.

By watching the coolant flow from the vents hoses you can determine if the coolant recovery check valve is moving when cabin heating is requested.

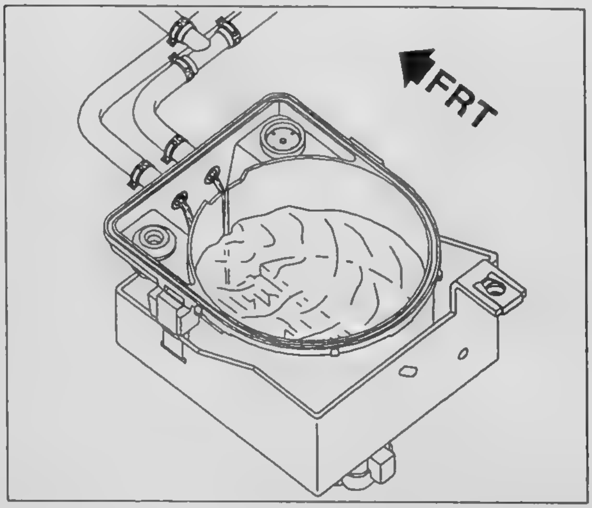
6. Turn On heater.
7. Monitor coolant flow through the vent hoses into the expansion tank. After about 5 seconds, the coolant from the radiator vent hose on the left side should decrease and almost stop. This indicates that coolant recovery check valve has moved into the heat mode and is diverting the coolant from the radiator to the heater core.
8. Turn Off heater.



PSMPEN67368AA

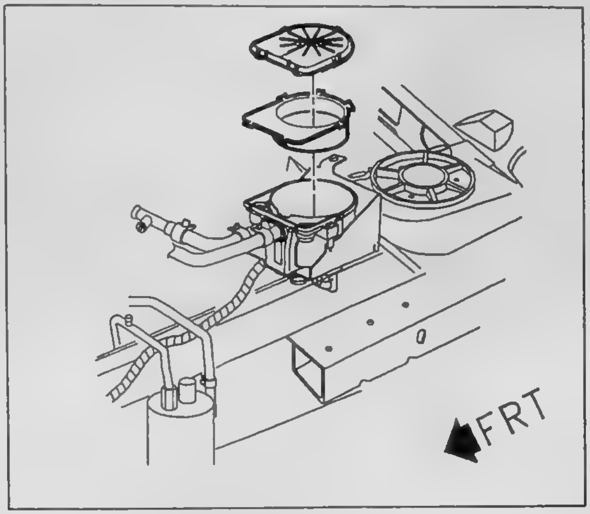
9. With vehicle in RUN mode and heater system in the Off mode, insert a charger paddle into charge receptacle, and verify that the charger is operating.
10. Monitor coolant flow through the vent hoses into the expansion tank. After about 5 seconds, the coolant flow from the left vent hose will decrease in pressure and the right vent hose should remain the same. This indicates that the driver motor charger receptacle valve has moved and is diverting coolant through the charger receptacle.

When the charger paddle is removed, there will be an increase in pressure through both vent hoses in the expansion tank as the valve closes and then the flow will return to a steady stream.

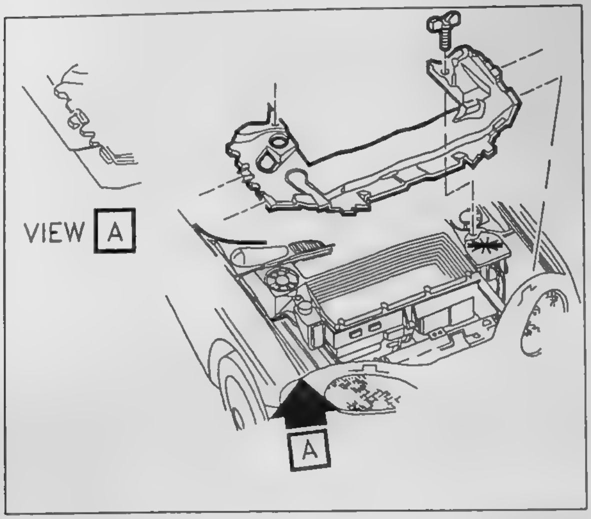


PSMPEN67369AA

11. Fill coolant to fill line on expansion tank.
12. Install expansion tank cover.



PSMPEN66720AA



PSMGEP65869AC

13. Install engine compartment sight shield.

DRIVE MOTOR COOLANT TEMPERATURE SENSOR

REMOVAL

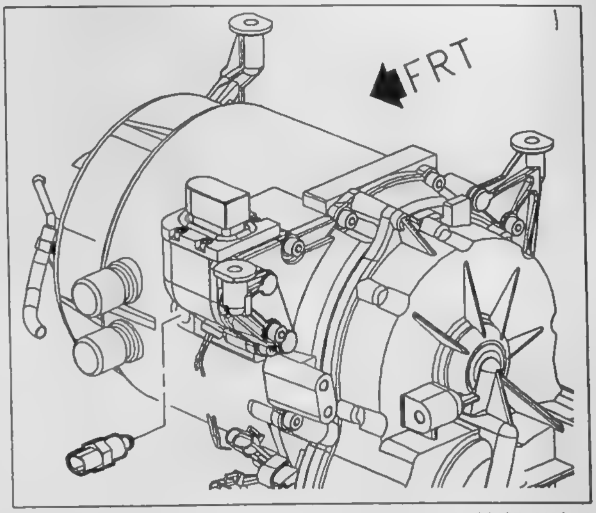
1. Remove the engine compartment sight shield.
2. Disconnect the wiring harness on the coolant temperature sensor.
3. Remove the drive motor coolant temperature sensor.

INSTALLATION

1. Apply thread sealant to drive motor coolant temperature sensor.
2. Install coolant temperature sensor.

Torque: 14 N•m (124 in−lbs)

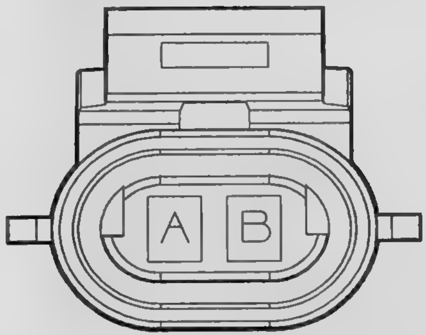
3. Connect wiring harness.
4. Install engine compartment sight shield.



PSNPEN66854AA

HARNESS CONNECTOR FACES

MOTOR WINDING TEMPERATURE SENSOR



GRAY
12052644

PSMELC66031AA

MOTOR WINDING TEMPERATURE SENSOR – 12052644				
CAVITY	WIRE COLOR	CIRCUIT NO.	WIRE-SIZE	CIRCUIT FUNCTION
A	LT GRN	37	.50	SENSOR HI
B	GRA/BLK	1798	.50	GROUND

Location: Underhood, Top Center of Drive Motor

NOTES

BATTERY SYSTEM INTERFACE

When the battery pack HV relays are closed high voltage is supplied to the power inverter module (PIM) bus bar. From the bus bar high voltage DC is supplied to the accessory AC and DC power control module (APM), power steering control module (PSCM) and the drive motor convert power function which provides power to the drive motor. The bias control assembly (BCA) monitors the available voltage at the bus bar. It sends this voltage value to the PCM as scaled battery voltage (1 volt = 100 volts). The scaled battery voltage is used for motor control.

The drive motor battery pack module (BPM) sends to the PCM the following STATUS:

- Charge coupler present
- Battery pack (BP) malfunction
- BP voltage fault
- BP current fault
- Auto disconnect open
- BP current (−400 to 400 amps)
- Maximum Regen voltage (0−500 volts)
- PSOC (pack state of charge)

BATTERY PACK

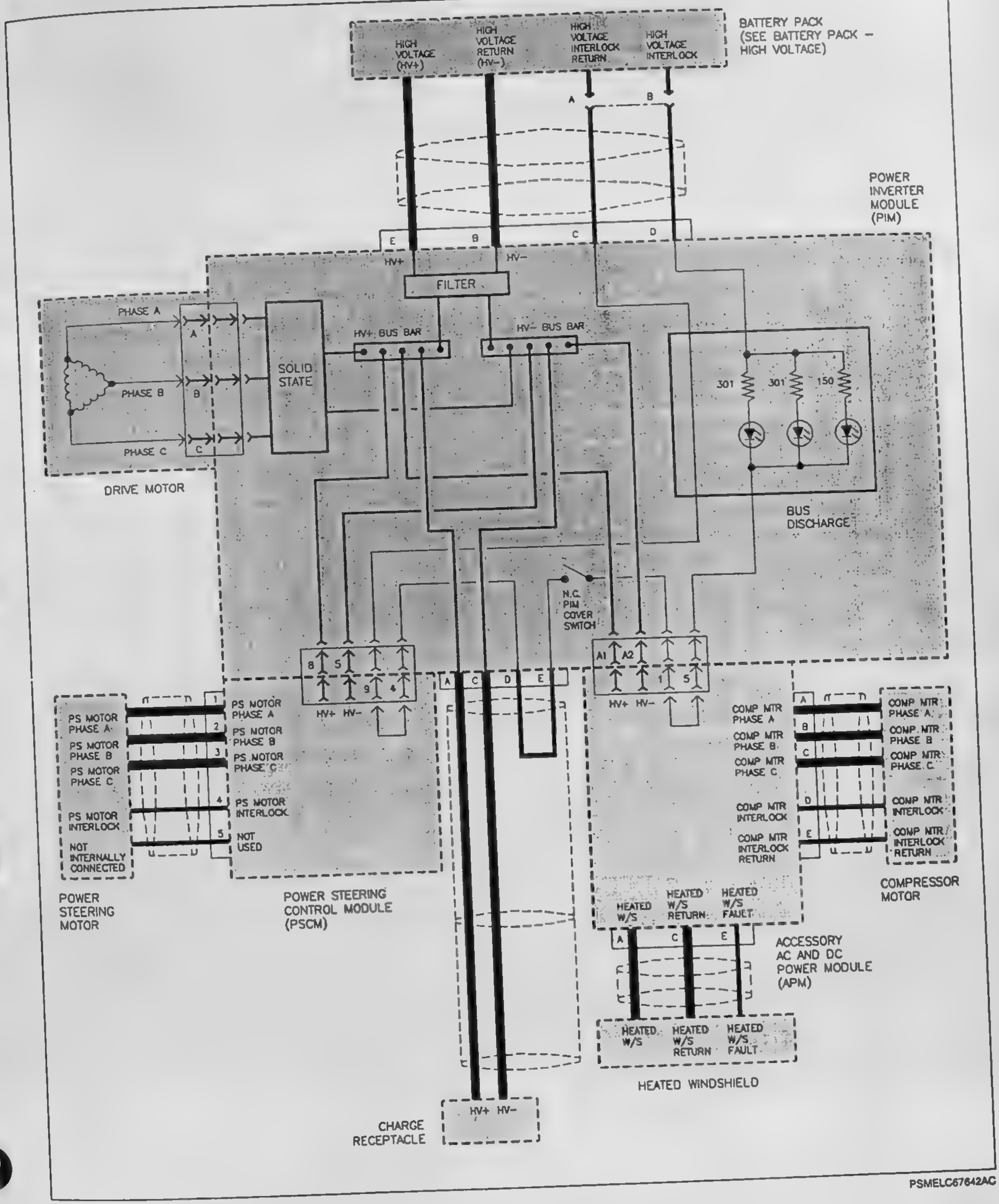
The battery pack always has high voltage DC present. The nominal voltage of the battery pack is 312 volts. The pack voltage is higher during charging or regeneration. The voltage in the battery pack is sent to the vehicle (PIM) by two large relays. When these relays are closed pack voltage is present at the PIM. Under normal operating conditions the relays are always closed, however if a fault in the high voltage system is detected or the manual disconnect is removed the relays are opened.

If the battery pack is removed from the vehicle additional steps must be taken to reduce the voltage to a safe level for working on the battery pack. Some diagnostic procedures will require you to work with the pack at full voltage and special care must be taken to follow the service manual procedures.

HIGH VOLTAGE INTERLOCK LOOP

The high voltage (HV) interlock loop is a separate low voltage series circuit that parallels all of the high voltage circuits. All of the high voltage DC connectors and cover switches are tied together in this isolated series single wire interlock loop. The PIM monitors the high voltage interlock loop circuit. If the loop is opened anywhere along its path, the high voltage relays will be opened and the PIM will discharge the bus capacitors to less than 42.4 volts within 250 milliseconds.

The PIM also contains a regeneration shutdown function that monitors the HV interlock power. The PIM will prevent the regeneration function within 40 milliseconds after the loss of HV interlock or loss of HV power.

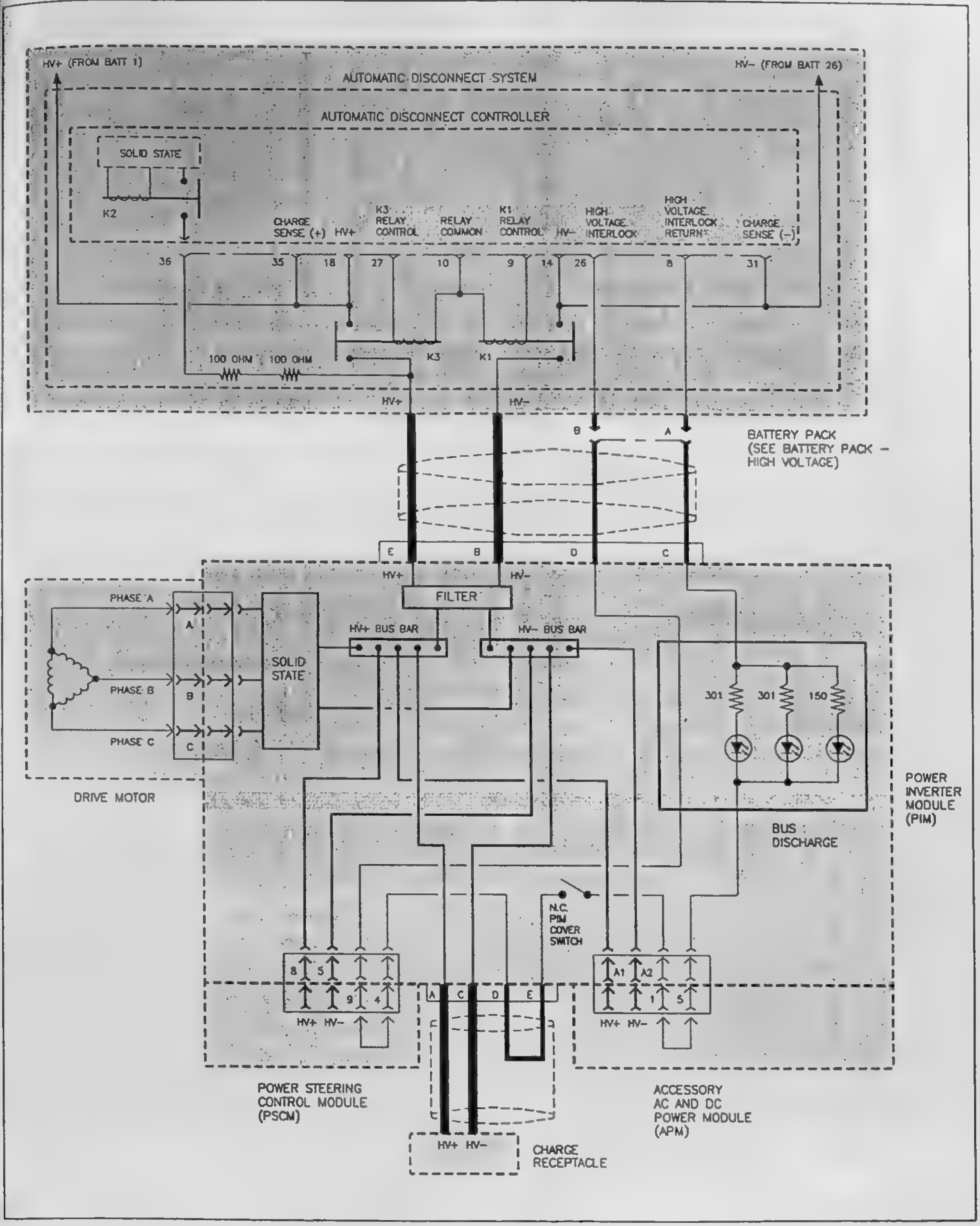

BATTERY PACK (SEE BATTERY PACK – HIGH VOLTAGE)
HIGH VOLTAGE (HV+)
HIGH VOLTAGE RETURN (HV–)
HIGH VOLTAGE INTERLOCK RETURN
HIGH VOLTAGE INTERLOCK
POWER INVERTER MODULE (PIM)
FILTER
HV+ BUS BAR
HV– BUS BAR
SOLID STATE
PHASE A
PHASE B
PHASE C
DRIVE MOTOR
301
301
150
BUS DISCHARGE
N.C. PIM COVER SWITCH
PS MOTOR PHASE A
PS MOTOR PHASE B
PS MOTOR PHASE C
PS MOTOR INTERLOCK
NOT INTERNALLY CONNECTED
NOT USED
POWER STEERING MOTOR
POWER STEERING CONTROL MODULE (PSCM)
COMP MTR PHASE A
COMP MTR PHASE B
COMP MTR PHASE C
COMP MTR INTERLOCK
COMP MTR INTERLOCK RETURN
COMPRESSOR MOTOR
HEATED W/S
HEATED W/S RETURN
HEATED W/S FAULT
ACCESSORY AC AND DC POWER MODULE (APM)
HEATED WINDSHIELD
CHARGE RECEPTACLE
HV+
HV–
PSMELC67642AC

PRECHARGE

Whenever the HV relays are opened, a precharge of the relay contacts is performed before the relays are turned on again. This reduces arcing across the contacts as they close. When the vehicle is placed in the Run mode, if the relays open, the AD system initiates a precharge. The negative bus relay and a low current relay in the AD controller will close, charging a PIM "precharge" capacitor. This capacitor will be charged until it reaches 90 percent of battery pack voltage. This should occur within seven seconds and pack current from the low current relay should be no greater than 3 amps. If precharge completes successfully the positive bus relay will close and the low current relay in the AD controller will open allowing normal system operation. If precharge has not been completed within 10 seconds then a precharge fault code is set, all relays are commanded open, and the "Wait" telltale is illuminated.

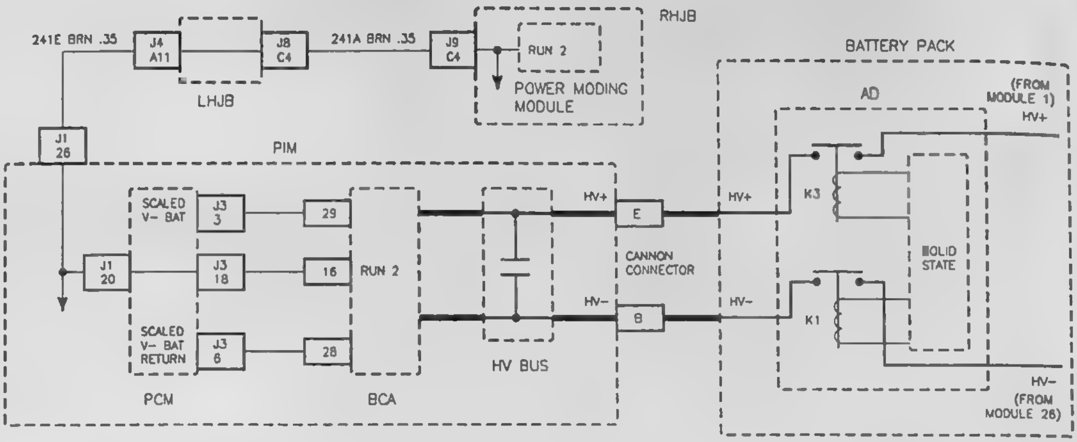
HIGH VOLTAGE BUS DISCHARGE

When the relays are commanded open, the PIM will discharge the bus through the discharge card in the PIM. The PIM will discharge the bus capacitors to less than 42.2 volts within 250 milliseconds. The HV relays must be open when the PIM is discharging the bus capacitors, or full pack capacity will remain across the capacitors. If this occurs, the discharge board will be damaged and discharge may not occur. If a failure occurs in the discharge circuit high voltage could be present in the PIM with the relays open. Always run the High Voltage Special Test before disconnecting the PIM. If the High Voltage Special Test cannot be run, follow the "High Voltage Present at PIM Discharge" procedure in this service manual.



PSMELC67643AD

DTC 005 – PACK VOLTAGE SENSED LOW IN POWER INVERTER MODU (PIM)



PACK VOLTAGE SENSED LOW IN POWER INVERTER MODULE (PIM)

The PCM monitors the battery pack voltage continuously during operation. The bias control assembly (BCA) supplies an isolated, scaled (1 volt = 100 volts) battery voltage signal to the propulsion control module (PCM).

DTC PARAMETERS

The DTC will set any time the battery pack voltage read by the PCM is less than 180 volts.

ACTION TAKEN BY THE PCM

The SERVICE NOW telltale is illuminated, the DTC will be stored, and propulsion is disabled.

This DTC may indicate the battery pack was severely discharged. Inform customer this condition reduces battery life.

RELATED DTCS

BPM 220, 221, 230, 231 or any module under voltage, marginal or out of range DTCs.

TELLTALE ILLUMINATED:

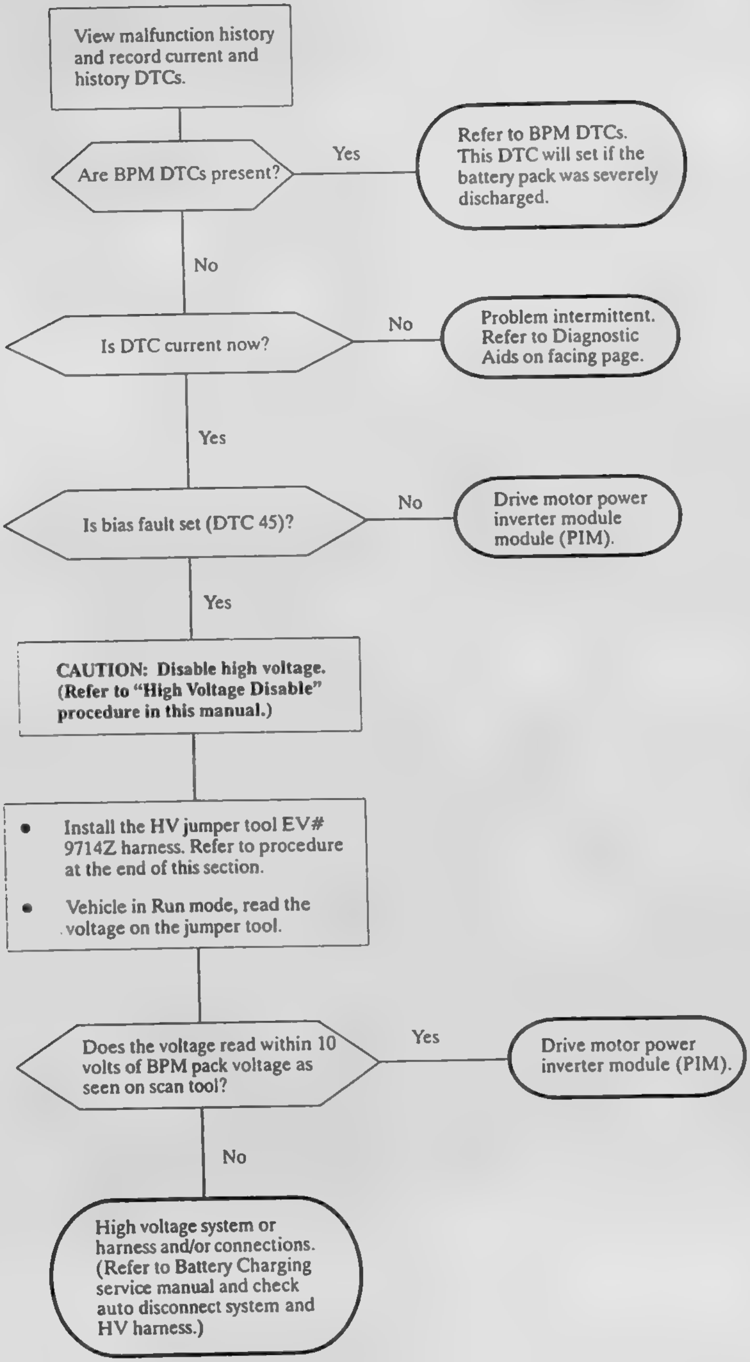
SERVICE NOW BPM codes for this same condition may turn on BATTERY LIFE telltale.

DIAGNOSTIC AIDS

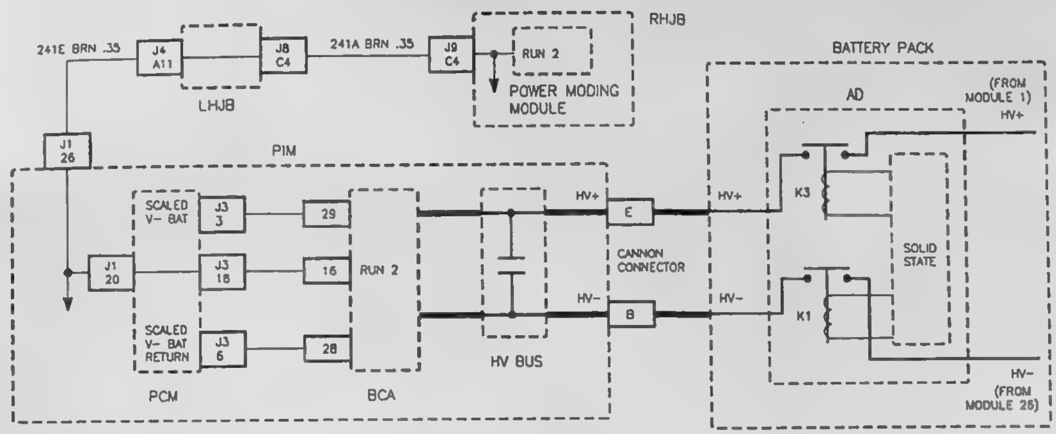
- Check for BPM DTCs first.
- Compare BPM and PCM pack voltages.
- If malfunction history data indicates USOC was less than 0% (PSOC = 15%) when failure occurred, the battery pack was driven to a severe state of discharge and damage may have occured.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- This failure may be caused by an open in the high voltage supply to the PIM, failure of the BCA circuitry or by an extremely discharged or failed battery pack.

* Select Malfunction History from the Scan tool PCM menu.

DTC 005
PACK VOLTAGE SENSED LOW IN POWER INVERTER MODULE



DTC 006 – PACK VOLTAGE SENSED HIGH IN POWER INVERTER MODULE (PIM)



PSMELC67651AC

PACK VOLTAGE SENSED HIGH IN POWER INVERTER MODULE (PIM)

The propulsion control module (PCM) monitors the battery pack voltage continuously during operation. The bias control assembly (BCA) supplies an isolated, scaled (1 volt = 100 volts) battery voltage signal to the PCM.

DTC PARAMETERS

The DTC will set any time the battery pack voltage read by the PCM is greater than 440 volts.

ACTION TAKEN BY THE PCM

The SERVICE NOW telltale will be illuminated and the DTC will be stored, and propulsion will be disabled. This fault is latched for the remainder of the ignition cycle.

RELATED DTCS

BPM 222, or battery module over–voltage DTCs.

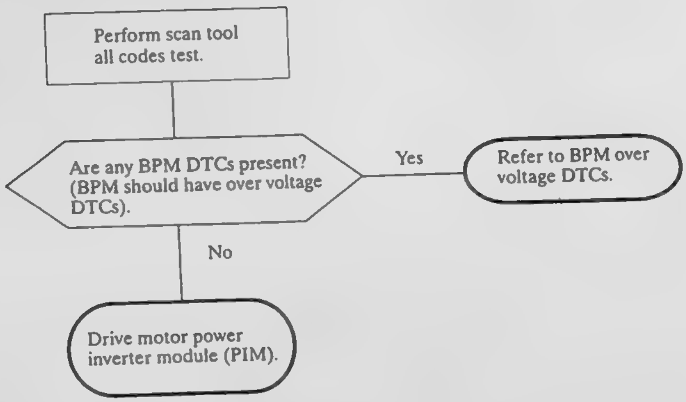
TELLTALE ILLUMINATED:

SERVICE NOW

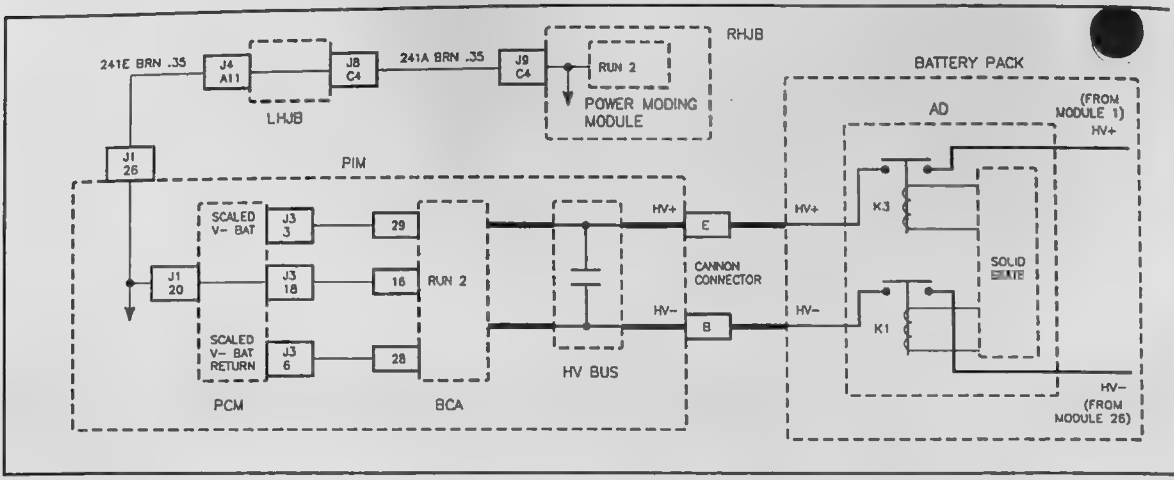
DIAGNOSTIC AIDS

- If DTC is not current view, refer to the charging event history tables. If the failure occurred during charging, you should see a charging event that did not go to complete with high pack voltages. This may indicate a problem with the customer's charger.
- Plug in a shop charger and verify failure does not occur. May need to have customer's charger tested also.
- This failure could be caused by a failure of the BCA circuitry.
- View malfunction History. If DTC set during Regen, the failure is most likely in the PIM. Duplicate the driving conditions to verify.

DTC 006
PACK VOLTAGE SENSED HIGH IN POWER INVERTER MODULE



DTC 053 – LOW BATTERY POWER OUTPUT CAPABILITY DETECTED



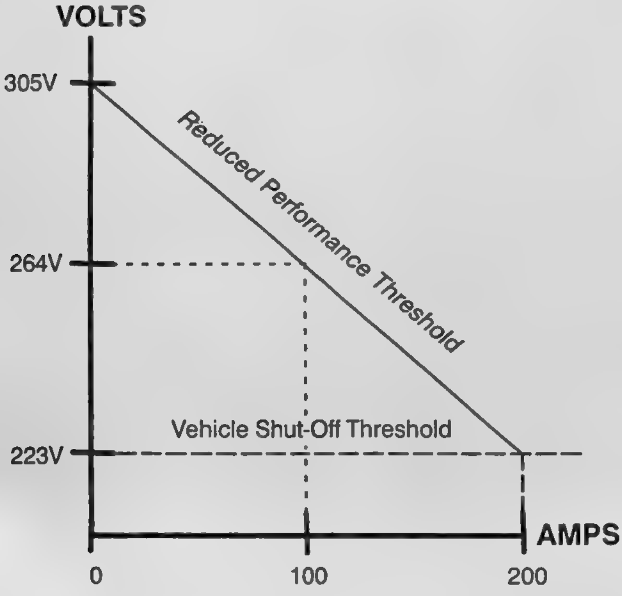
PSMELC67651A(

LOW BATTERY POWER OUTPUT CAPABILITY DETECTED

The propulsion control module (PCM) monitors the battery pack voltage continuously during operation. The bias control assembly (BCA) supplies an isolated, scaled (1 v = 100 v) battery voltage signal to the PCM. This circuitry is internal to the power inverter module (PIM). The PCM also receives battery current from the battery pack module (BPM) via serial data. The PCM looks at battery voltage sag as a function of current in order to detect low battery power output capability.

DTC PARAMETERS

The DTC will set when the PCM senses excessive voltage sag (scaled battery voltage) as a function of battery current continuously for a period of 30 seconds (refer to chart below).



ACTION TAKEN BY THE PCM

The REDUCED PERFORMANCE telltale is illuminated, the DTC is stored, the vehicle enters reduced performance mode and the fault is latched for the duration of the ignition cycle or until the charge coupler is inserted into the charge receptacle.

RELATED DTCS

BPM 230, 231, 220, 221, or any module under voltage, marginal or out of range DTCs.

TELLTALE ILLUMINATED:

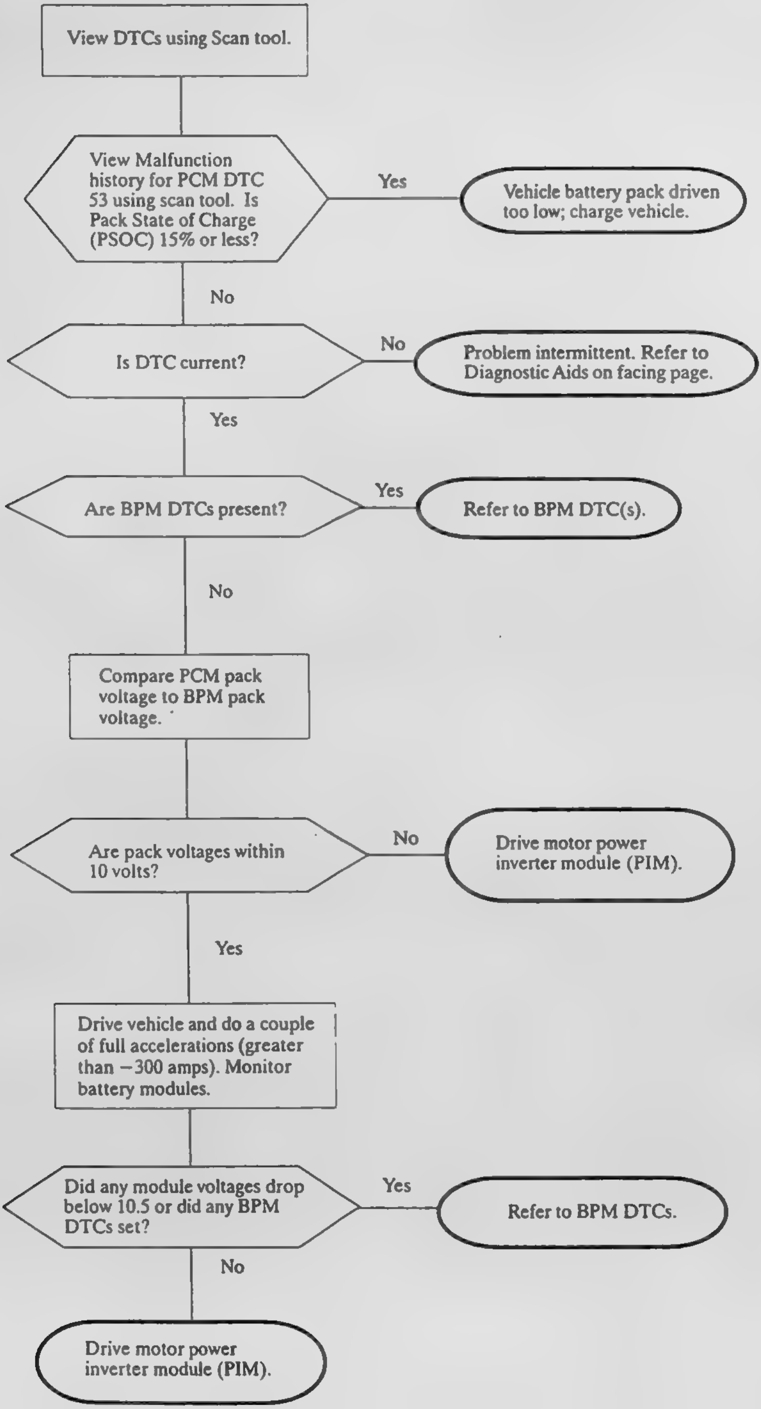
REDUCED PERFORMANCE

DIAGNOSTIC AIDS

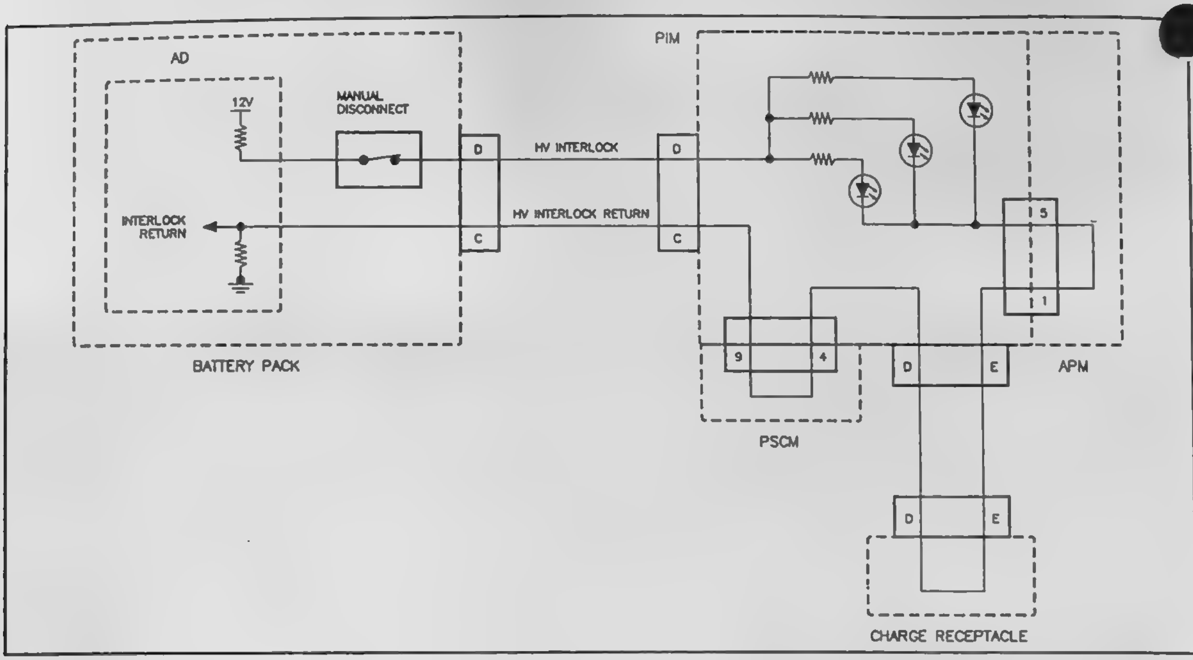
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- Compare BPM and PCM battery pack voltages. They should be within 10 volts of each other.
- In some cases, PCM can detect low power output before the BPM. If the DTC sets with less than −200 amps coming from the pack, drive the vehicle and do a full throttle acceleration greater than −300 amps and watch for battery modules dropping out (less than 10.5 V) or BPM DT set. If modules look ok, this is most likely a problem.

* Select Malfunction History from the Scan tool PCM menu.

DTC 053
LOW BATTERY POWER OUTPUT CAPABILITY DETECTED



DTC 070 – HIGH VOLTAGE INTERLOCK LOOP FAILURE DETECTED



PSMELC67671AA

HIGH VOLTAGE INTERLOCK LOOP FAILURE DETECTED

The propulsion control module (PCM) receives two inputs which indicate, the status of the high voltage interlock loop. One input is the auto disconnect status from the BPM, the other is the HV interlock input from the photo diodes. The PCM continuously monitors these inputs so that it can disable propulsion.

DTC PARAMETERS

The DTC will set when the interlock current drops below one milliamp.

ACTION TAKEN BY PCM

A DTC is set and propulsion is disabled as long as the HV interlock fault is present. Normally, an interlock fault will trigger the opening of the auto-disconnect, which can be reset by placing the keypad in OFF or LOCK, then placing the keypad in Run.

RELATED DTCS

BPM 275

TELLTALE ILLUMINATED:

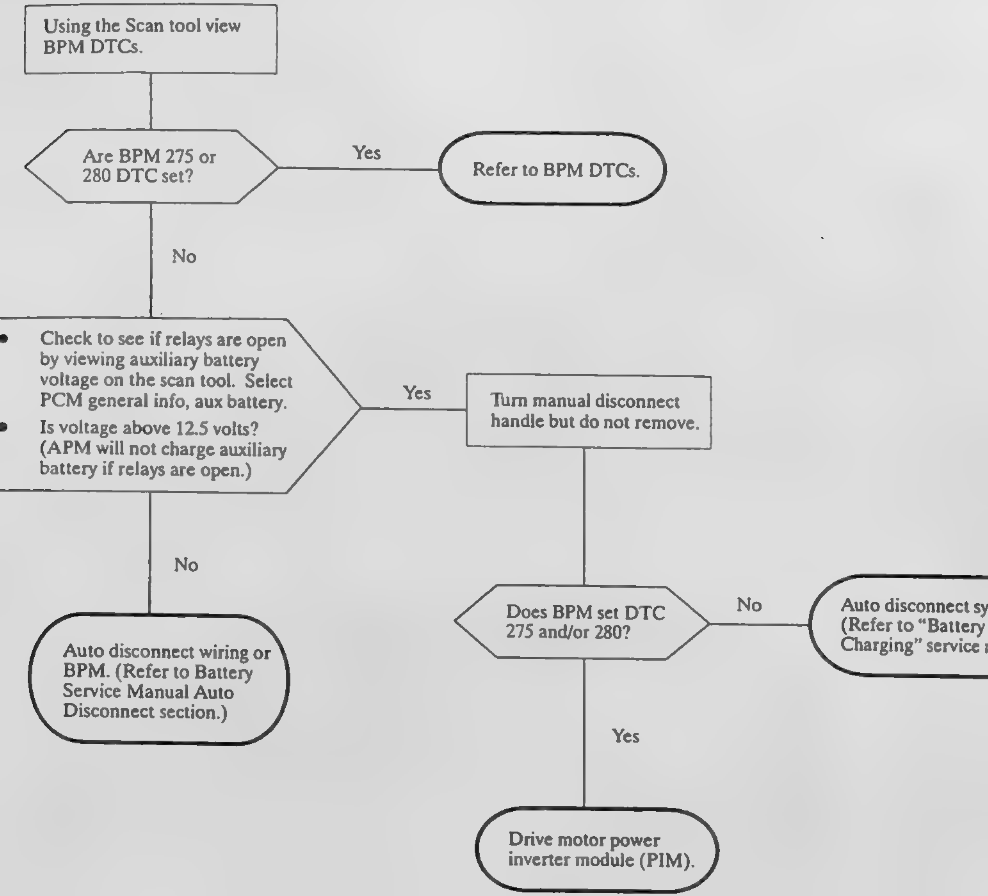
The PCM does not light a telltale for this event; however, the WAIT telltale will be lit whenever the auto-disconnect is open.

DIAGNOSTIC AIDS

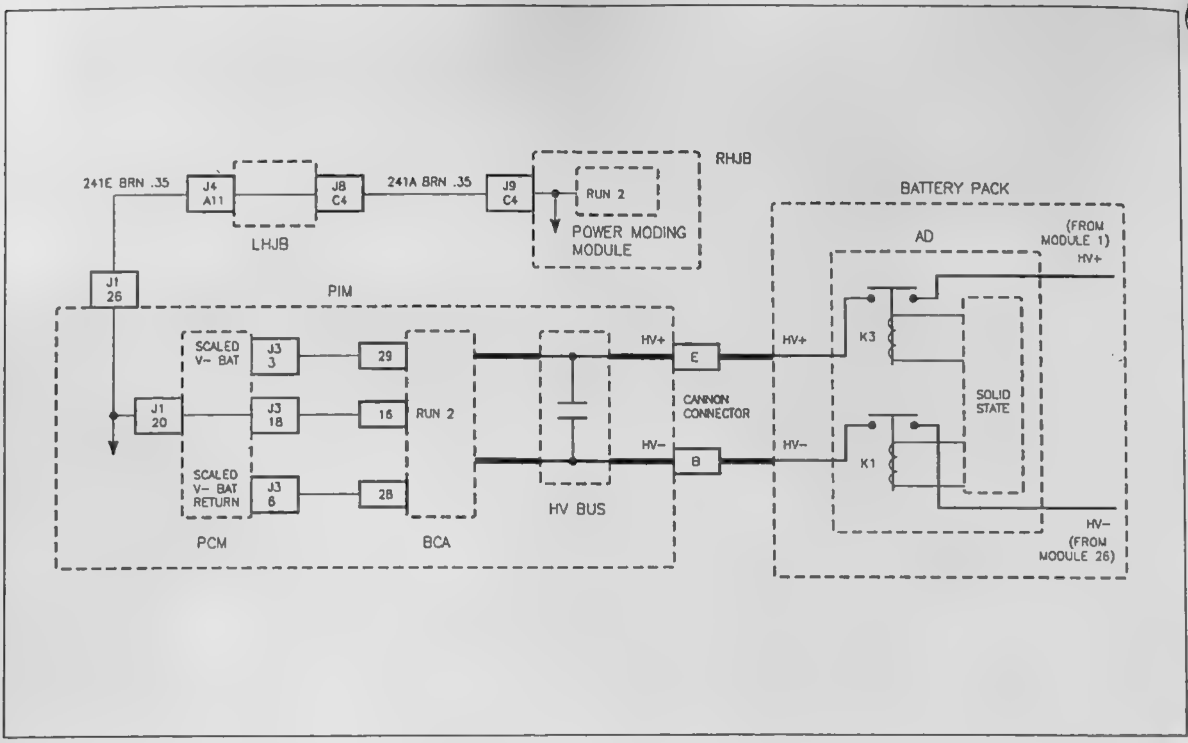
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.
- DTC 70 may set if the manual disconnect is removed.

* Select Malfunction History from the Scan tool PCM menu.

DTC 070
HIGH VOLTAGE INTERLOCK LOOP FAILURE DETECTED



DTC 071 – PACK VOLTAGE READS LOW AT POWER-UP



PSMELC67651AC

PACK VOLTAGE READS LOW AT POWER-UP

The propulsion control module (PCM) monitors the battery pack voltage continuously during operation. The bias control assembly (BCA) supplies an isolated, scaled (1 v = 100 v) battery voltage signal to the PCM. This circuitry is internal to the power inverter module (PIM) and is checked at startup to ensure it is within range.

DTC PARAMETERS

The DTC will set when the battery voltage read by the PCM is less than 280 volts at startup.

ACTION TAKEN BY THE PCM

A DTC is set, the SERVICE NOW telltale is illuminated, and propulsion is disabled. This fault is latched for the duration of the ignition cycle.

RELATED DTCS

BPM 230, 231, 220, 221, or any module under–voltage, marginal or out of range DTCs.

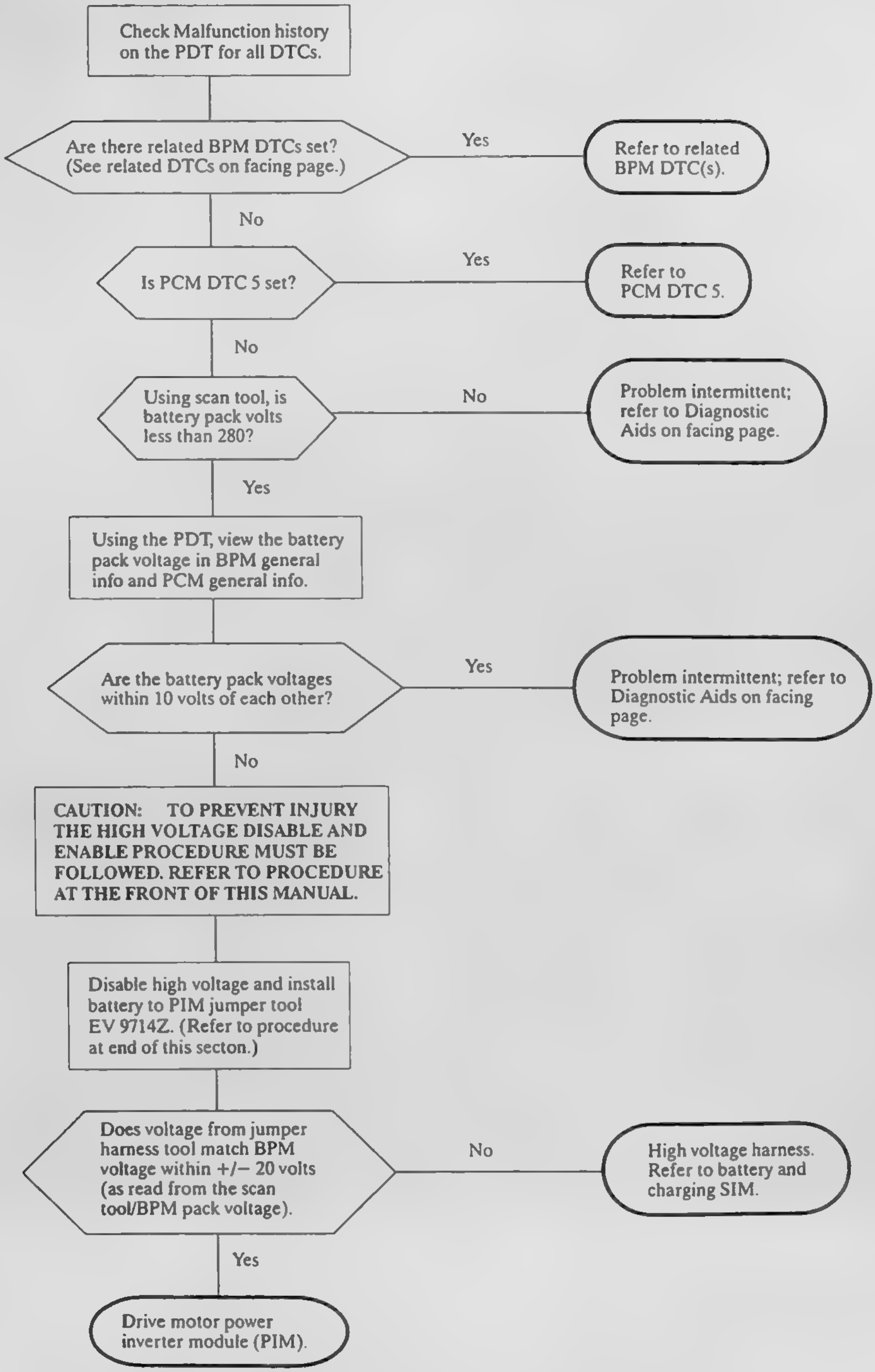
TELLTALE ILLUMINATED:

SERVICE NOW

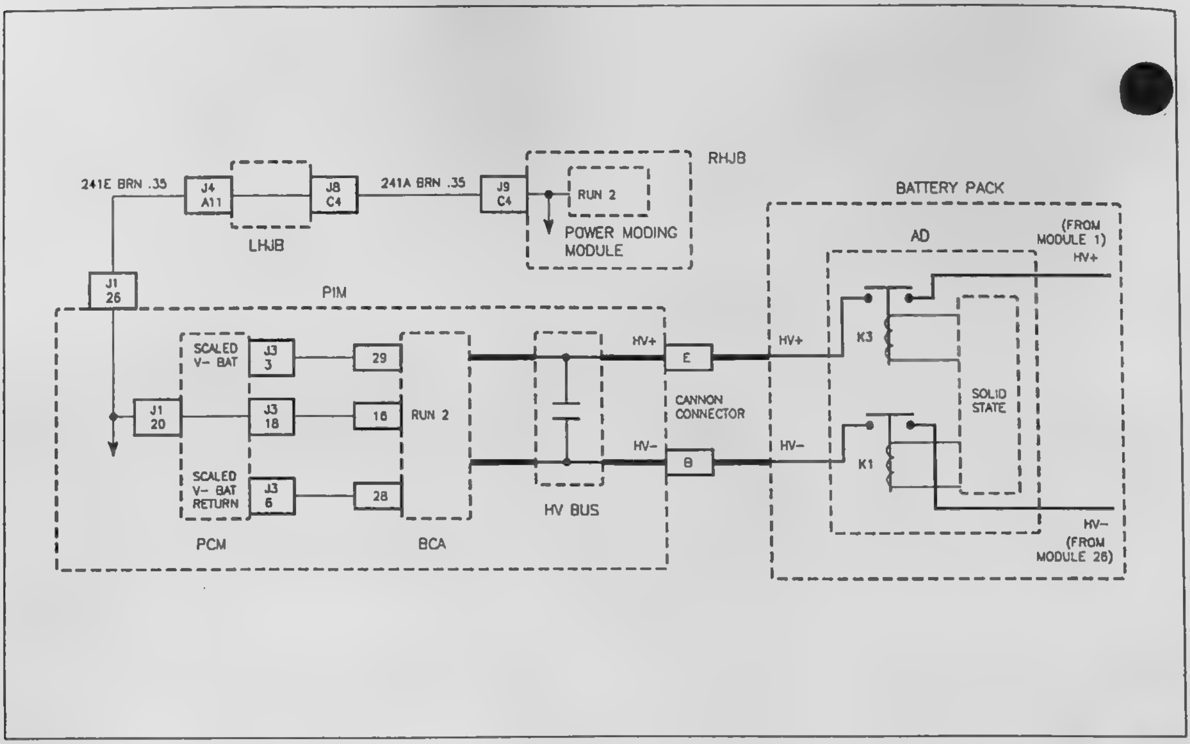
DIAGNOSTIC AIDS

- This could be caused by a failure of the BCA circuitry, by an open in the high voltage supply to the PIM, or by an extremely discharged or failed battery or battery pack.
- Review PCM malfunction history. A DTC 071, together with a low PSOC, indicates an extremely discharged battery pack.
- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

DTC 071
PACK VOLTAGE READ LOW AT POWER-UP



DTC 072 – PACK VOLTAGE READS HIGH AT POWER-UP



PSMELC67651AC

PACK VOLTAGE READS HIGH AT POWER-UP

The propulsion control module (PCM) monitors the battery pack voltage continuously during operation. The bias control assembly (BCA) supplies an isolated, scaled (1 v = 100 v) battery voltage signal to the PCM. This circuitry is internal to the power electronics bay (PEB) and is checked at startup to ensure it is within range.

DTC PARAMETERS

The DTC will set when the battery voltage read by the PCM is greater than 440 V at powerup and coupler not inserted.

ACTION TAKEN BY THE PCM

A DTC is set, the SERVICE NOW telltale is illuminated, and propulsion is disabled. This fault is latched for the duration of the ignition cycle.

RELATED DTCS

BPM 222 or any module over voltage.

TELLTALE ILLUMINATED:

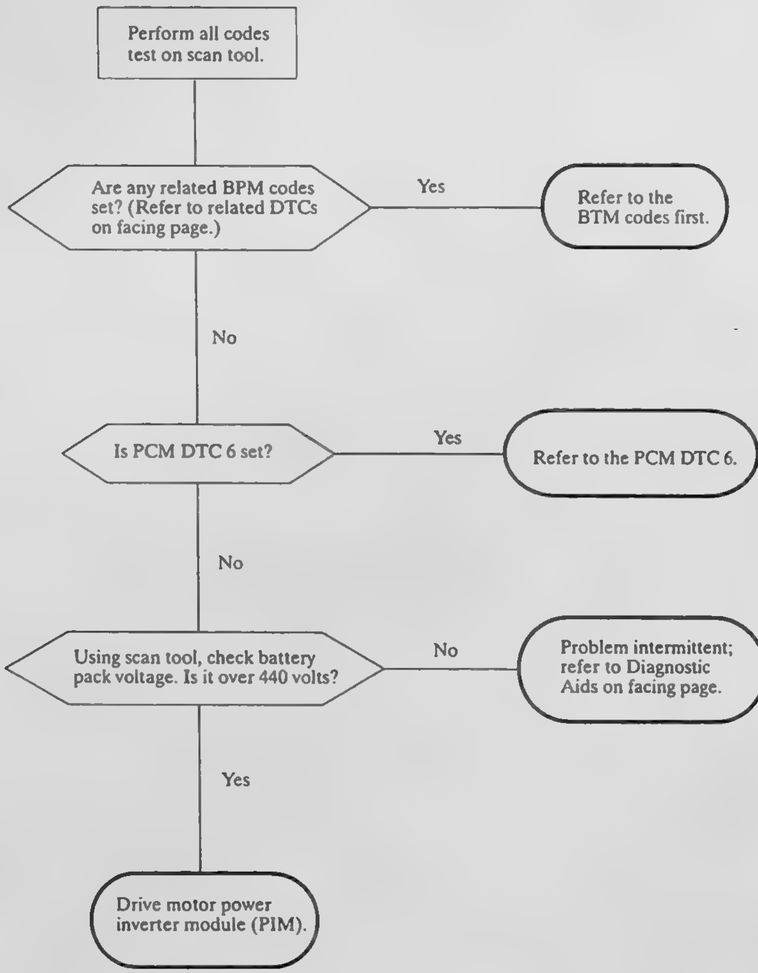
SERVICE NOW

DIAGNOSTIC AIDS

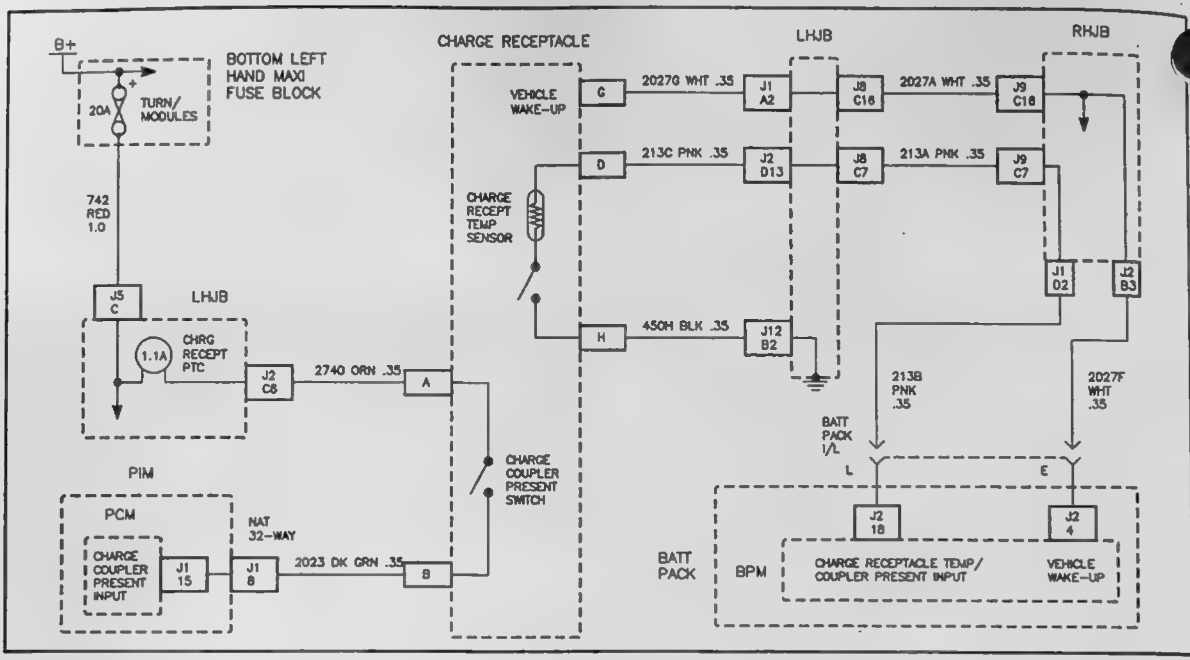
- View the charge event history tables. If DTC set after vehicle was pulled off charge and pack voltage was approximately 420 volts this is a normal condition.
- This could be caused by a failure of the BCA or PCM circuitry that senses pack voltage.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 072
PACK VOLTAGE READS HIGH AT POWER-UP



DTC 097 – DIFFERENCE IN PCM AND BPM COUPLER PRESENT INPUTS



PSMELC67661AB

DIFFERENCE IN PCM AND BPM COUPLER PRESENT INPUTS

The battery pack module (BPM) and propulsion control module (PCM) monitor the charge receptacle to indicate if the charge coupler is present. The PCM and BPM look at two different switches to determine if the coupler is present and compare their results over serial data.

DTC PARAMETERS

This DTC will set anytime the PCM coupler present input does not match the serial data coupler present from the BPM for 30 seconds.

ACTION TAKEN BY THE PCM

These actions are taken immediately by the PCM, before the code is set.

Park– BTSI locked

N– Loss of propulsion telltale illuminated.

D-R– No Effect

SERVICE SOON telltale is illuminated and the DTC is set after 30 seconds.

RELATED DTCS

BPM 287

TELLTALE ILLUMINATED:

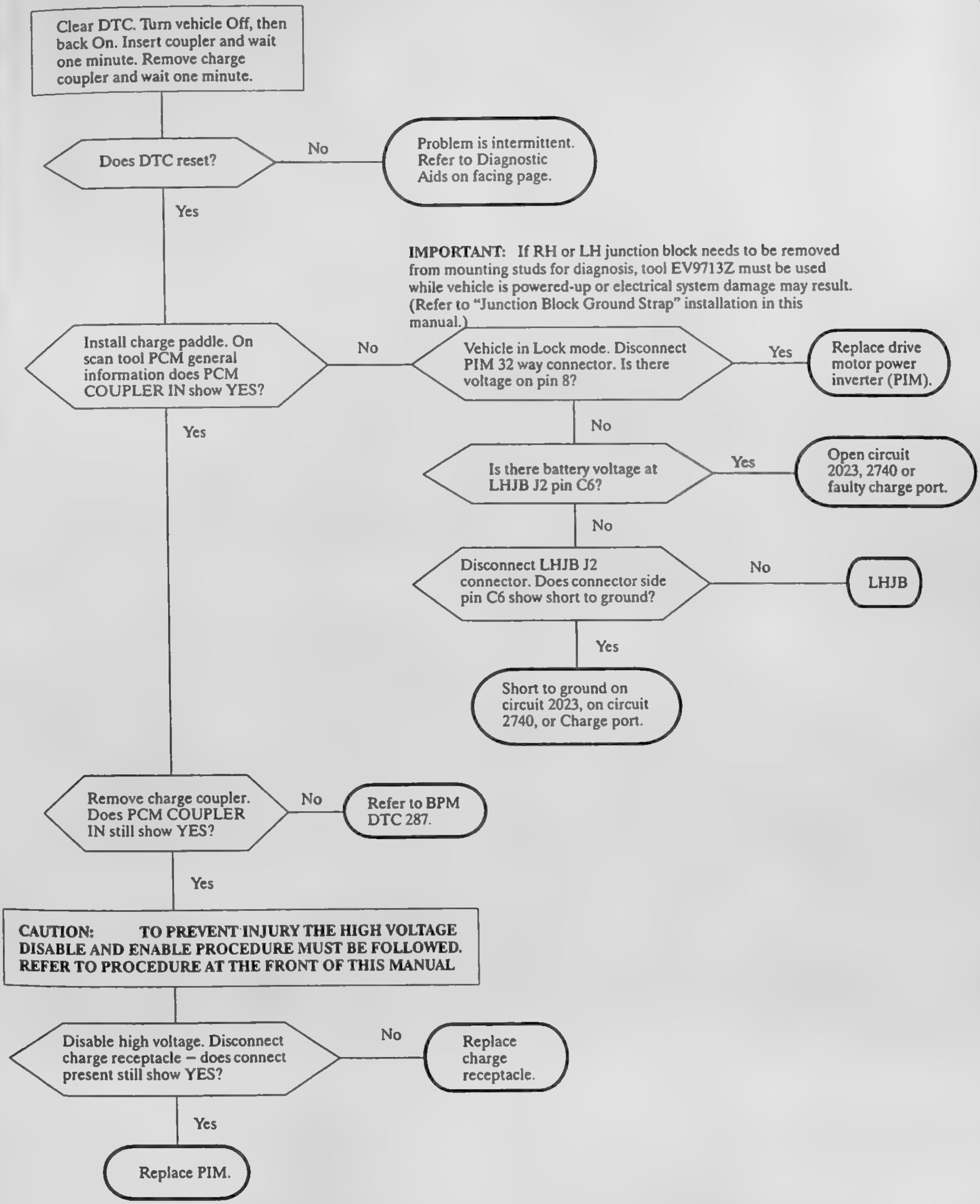
SERVICE SOON

DIAGNOSTIC AIDS

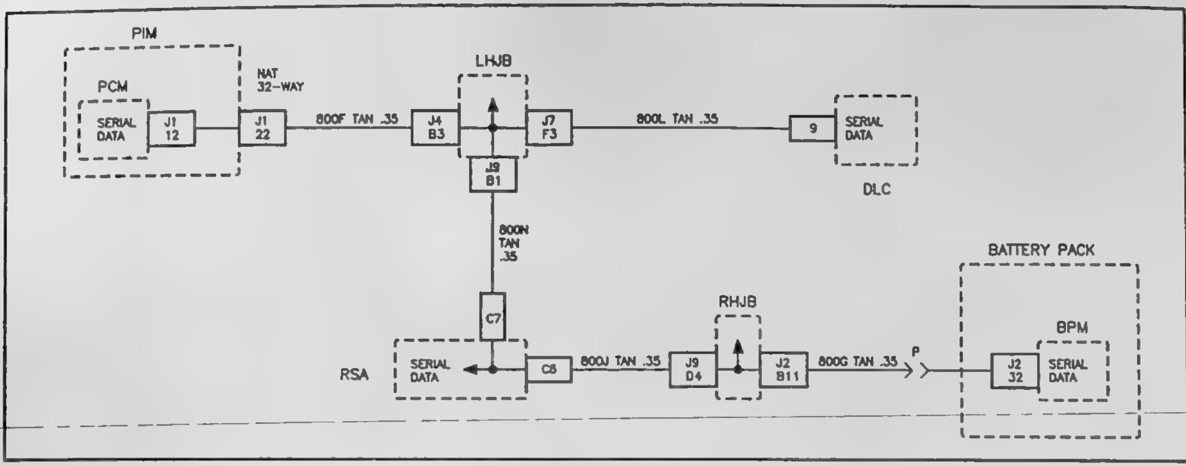
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

* Select Malfunction History from the Scan tool PCM menu.

DTC 097
DIFFERENCE IN PCM AND BPM COUPLER PRESENT INPUTS



DTC 102 – REDUCED PERFORMANCE MODE ENABLED DUE TO REQUEST FROM BPM



PSMELC67655AA

REDUCED PERFORMANCE MODE ENABLED DUE TO REQUEST FROM BPM

When the battery pack module (BPM) detects a battery over voltage or under voltage it will send a request via serial data to the propulsion control module (PCM) to initiate reduced performance. The PCM reduces the vehicle performance to a calibratable amount. This action helps protect the battery pack.

DTC PARAMETERS

This DTC sets anytime BPM requests reduced performance.

ACTION TAKEN BY THE PCM

The REDUCED PERFORMANCE telltale will be illuminated and DTC will be stored. The PCM will enter reduced performance and disable cruise control for the ignition cycle.

RELATED DTCS

BPM 230, 231, 221, 222

TELLTALE ILLUMINATED:

REDUCED PERFORMANCE

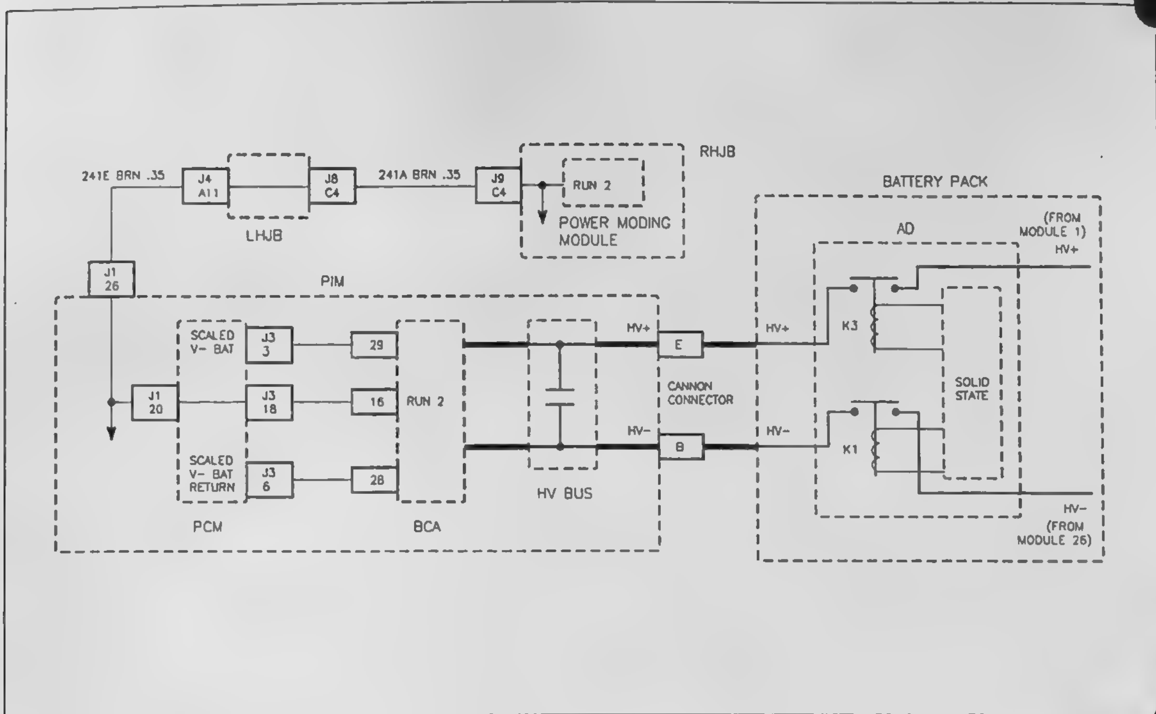
DIAGNOSTIC AIDS

- This DTC is a request for PCM to enter reduced performance mode, and does not indicate a failure of the PIM.

DTC 102
REDUCED PERFORMANCE MODE ENABLED DUE TO REQUEST FROM BPM

PCM DTC 102 does not indicate a failure of the PIM. It is a request from the BPM to enter reduced performance mode based on a low battery pack or module voltage. Refer to BPM DTCs.

DTC 105 – PCM DETECTS HIGH VOLTAGE PRESENT WHEN BPM HAS COMMANDED RELAYS OPEN



PSMELC67651A

PCM DETECTS HIGH VOLTAGE PRESENT WHEN BPM HAS COMMANDED RELAYS OPEN

The propulsion control module (PCM) monitors the high voltage scaled voltage battery circuitry to determine the status of voltage present. When the battery pack module (BPM) commands the relays to open it informs the PCM that the relays are open and the PCM expects to see the voltage drop to zero.

DTC PARAMETERS

IMPORTANT: This DTC will only set if the Scan tool high voltage test is run.

The DTC will set any time the BPM indicates high voltage interlock circuit is open for 250 ms and scaled Vbat (PCM BP voltage) reads greater than 42.5 volts when Run 1 is turned Off to the PCM and Run 2 is still On.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale is illuminated and the DTC is set.

CAUTION: THIS DTC INDICATES HIGH VOLTAGE IS PRESENT IN THE PIM.

RELATED DTCS

NONE

TELLTALE ILLUMINATED:

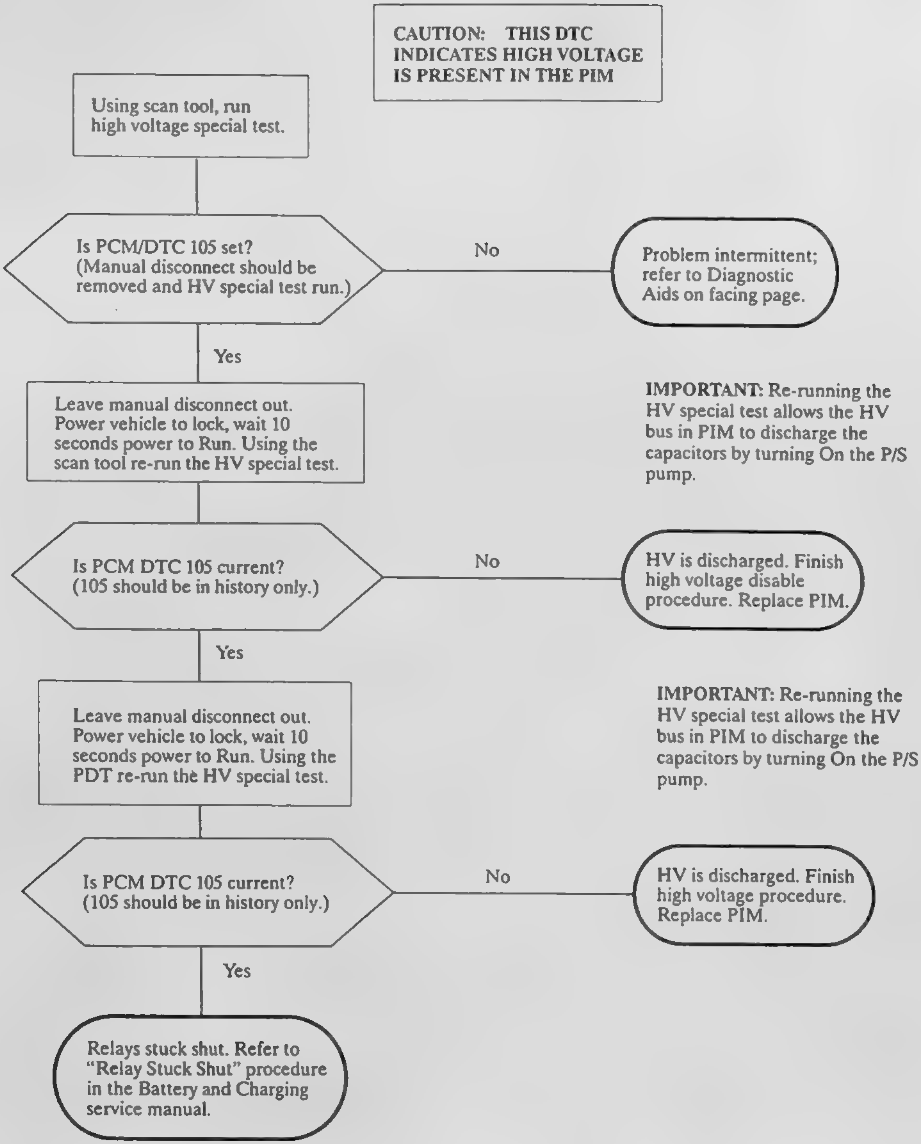
SERVICE SOON

DIAGNOSTIC AIDS

- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.
- If DTC 105 is set this indicates the PIM cannot discharge the HV bus. Run the high voltage special test and follow the HV disable procedure.

* Select Malfunction History from the Scan tool PCM menu.

DTC 105
PCM DETECTS HIGH VOLTAGE PRESENT WHEN BPM HAS COMMANDED RELAYS OPEN



HIGH VOLTAGE PRESENT-PIM DISCHARGE PROCEDURE

1. Place the vehicle in the lock mode.
2. Disconnect the PIM 32-way connector and install a diagnostic service probe on circuit 241 (RUN 2) cavity 26 of the 32-way.
3. Install the 32-way connector.
4. Connect a jumper to the positive terminal of the Auxiliary battery.
5. Connect the jumper lead to a DVOM meter lead and insert the meter lead in the diagnostic service probe.

NOTICE: The power steering pump should start running. Leave the 12 volts on circuit 241 until the power steering pump stops running.

6. If the power steering pump continues to run after five minutes, the auto disconnect relay(s) are stuck closed or AD System has malfunctioned. (Refer to relay stuck shut in the "Battery and Charging System" service manual.)
7. Follow the high voltage disable procedure to take down the high voltage.

HIGH VOLTAGE JUMPER HARNESS TOOL #EV9714Z

CAUTION: TO REDUCE THE RISK OF SEVERE SHOCKS AND BURNS, THE HIGH VOLTAGE SYSTEM SHOULD BE DISABLED ANY TIME SERVICE WORK IS BEING PERFORMED ON OR AROUND THE HIGH VOLTAGE SYSTEM. WHEN IN DOUBT, ALWAYS DISABLE THE HIGH VOLTAGE SYSTEM. THE 12 VOLT SYSTEM WILL STILL BE ACTIVE AFTER THE HIGH VOLTAGE SYSTEM HAS BEEN DISABLED.

INSTALLATION

1. Disable high voltage system. (Refer to "High Voltage Disable" procedure in the front of the manual.)
2. When high voltage system disable is complete, remove the battery pack to PIM cannon connector from the back right of the PIM.
3. Install the high voltage jumper harness tool cannon connector to the back of the PIM.

NOTICE: Do not use any tools to install the connector. Excessive force or misalignment can damage the connector pins.

4. Install the high voltage jumper harness tool cannon connector to the battery pack harness connector.

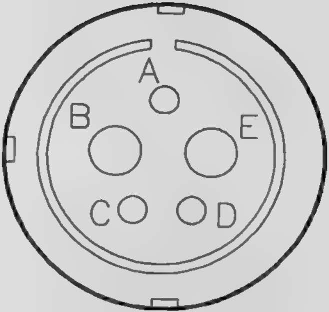
NOTICE: To prevent connector damage, make sure connectors are lined up before turning the connector into place.

REMOVAL

1. Disable the high voltage system. (Refer to "High Voltage Disable" procedure in the front of the manual.)
2. Before removing the jumper tool make sure the voltage reading on the tool is zero volts. Remove the jumper harness tool to PIM cannon connector from the back right of the PIM.
3. Remove the high voltage jumper harness tool to battery pack harness cannon connector.
4. Install the battery pack to PIM cannon connector to the back right of the PIM.

NOTICE: Do not use any tools to reinstall the connector. Excessive force or misalignment can damage the connector pins.

5. Enable the high voltage system. (Refer to "High Voltage Disable" procedure in the front of the manual.)

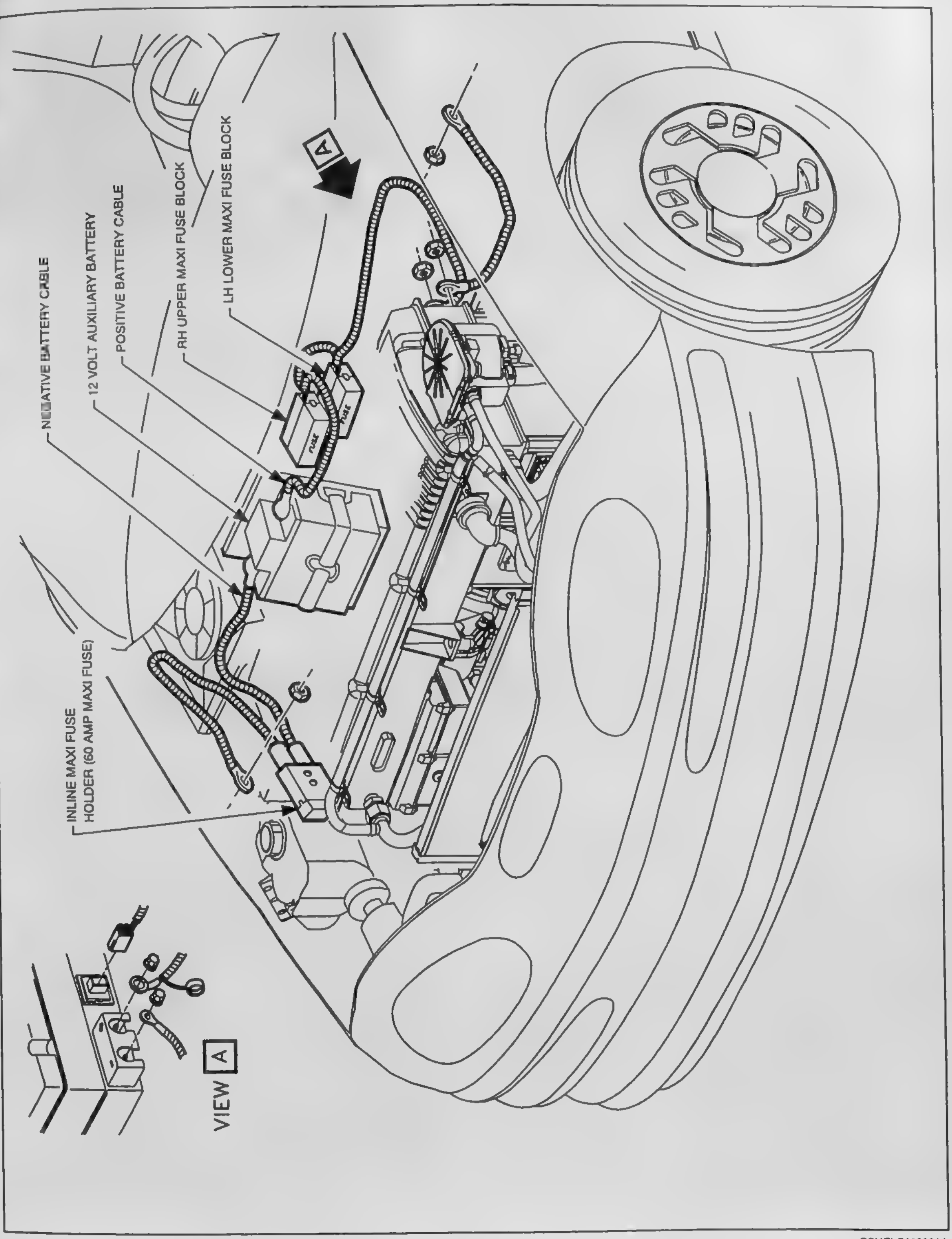


CANNON
CONNECTOR

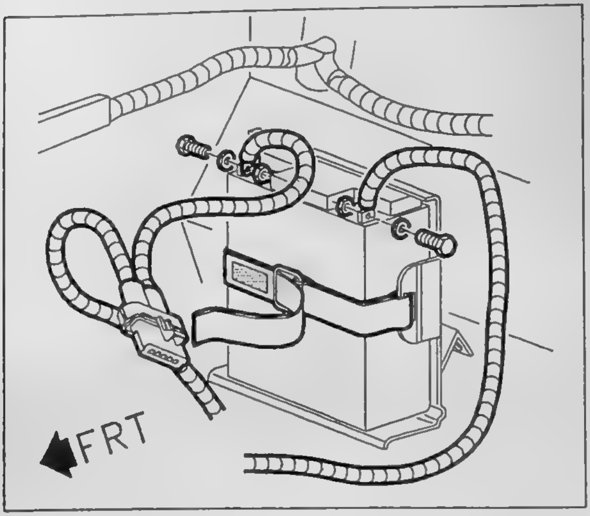
PSMELC68240AA

BATTERY	
CAVITY	WIRE COLO
A	
B	
C	
D	
E	

Location: Underhood, Re



PSMELC68309AA



PSMPEN66663AA

AUXILIARY BATTERY

The auxiliary (Aux) battery is a valve regulated sealed lead acid 12 volt battery. The amp hour rating of the Aux battery is relatively low at 17.5 amp-hours. This is much smaller than a normal internal combustion vehicle battery. As a result it will discharge much faster if electrical loads are left On when the vehicle is in the Lock or Off/Acc mode and not charging. For this reason it is recommended that no after-market equipment be added to the electrical system, especially if they use power in the Off/Acc or Lock modes. As long as the main battery pack is kept charged and the vehicle is Run mode the Aux battery will remain charged.

When the vehicle is Off or in Lock, the Aux battery provides power to all of the controllers for memory storage and all 12 volt systems. Loss of the 12 volts from the Aux battery during the vehicle Lock mode (when not charging) will cause all of the on-board controllers to go through a reset and most of the controllers will lose any stored DTC information.

If the Aux battery is at such a low voltage that the vehicle will not power on, the battery recovery switch may be used to power up the system. Once the system is up the APM will provide current for charging the aux battery and operating the 12 volt system. Refer to "Aux Battery Recovery" in this section.

NOTICE: Never attempt to jump start the vehicle or Aux battery. If jump starting is attempted, the vehicle systems may be damaged.

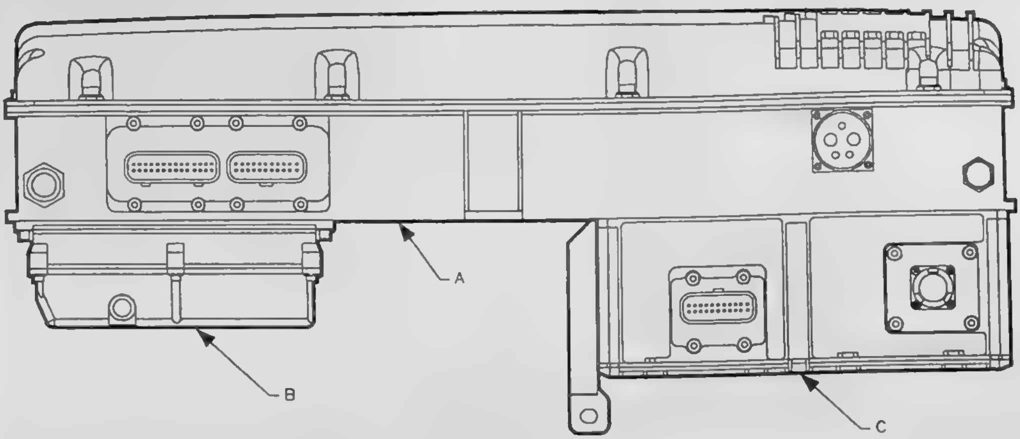
STORAGE OF THE AUXILIARY BATTERY WHEN NOT IN THE VEHICLE

The Auxiliary battery should be stored at temperatures between 10–35°C (50–95°F). Batteries stored in temperatures below 0°C (32°F) could freeze and cause irreversible damage to the battery. Batteries stored above 40°C (104°F) will cause a higher self-discharge rate. If a battery sits in a discharged state, it will result in irreversible damage to the battery.

FREQUENCY OF RECHARGE (FOR STORED BATTERIES)

If an Aux battery is stored, it should be charged every 60 days. (Refer to "Aux Battery Recharge" procedure in the "Battery and Charging" service manual.) Batteries which are recharged less frequently may be irreversibly damaged.

ACCESSORY AC AND DC POWER MODULE (APM)



PSMPEN66845A8

A – Drive motor power inverter module (PIM)
B – Power steering control module (PSCM)
C – Accessory AC and DC power module (APM)

The APM is part of the PEB and is attached to the bottom left side of the PIM.

The APM has four major functions; to provide:

- 13.5 or 14.5 volts DC for Auxiliary battery charging and 12 volt systems
- 47 volt DC for the heated windshield
- 3-phase AC voltage for the compressor heat pump
- feedback to the HTCM about system operation to help diagnose problems

The APM will operate on battery pack voltages between 225 and 430 volts. The APM will shut itself down if the voltage drops below 215 volts ± 10 volts. It will not be damaged by this condition and will wake-up when adequate voltage is restored.

Although the APM receives DC voltage that may vary from 225 to 430 volts it must hold its output DC voltage steady for the auxiliary battery and heated windshield applications. Additionally, the APM converts DC voltage to AC voltage to operate the compressor motor.

The APM will only turn On when the vehicle run command or vehicle wake-up command inputs are active and the battery pack voltage is between 225 and 430 volts.

AUXILIARY BATTERY POWER

Whenever the APM is awake it provides a steady DC power source to charge the auxiliary battery and supply power to the 12 volt systems. This voltage may be held at either 13.5 ± .25 volts or 14.5 ± .25 volts depending on what is commanded by the battery pack module (BPM). The normal operating level is 13.5 volts but during colder temperatures (15°C [59°F] and below) the 14.5 volt level may be commanded. The command from the BPM comes over circuit 249 to APM 24 pin connector pin 2. If the voltage on this line is above 7.0 volts it is considered high and the APM outputs 14.5 volts. If the voltage on the line is below 2.0 volts it is considered low and the APM outputs 13.5 volts.

The APM is able to output up to 100 amps of current as long as the battery pack voltage level is between 225 and 430 volts. The APM puts out this power at 85 percent efficiency in the normal range of 250 – 390 volts and at least 80 precent efficiency over the entire range of 225 – 430 volts under moderately heavy loads.

HEATED WINDSHIELD (HWS) CONTROL

The APM supplies a regulated DC voltage of 47 volts to the HWS upon a HWS ON command. The HWS ON command is issued by the HTCM over circuit 637. If the circuit is above 8.0 volts the APM considers it high and turns the heated windshield On. If it is below 2.0 volts the APM considers it low and turns the HWS Off. An open circuit results in a high signal at the APM.

APM output voltage will be turned Off when the heated windshield is commanded OFF or a short to 47 volt power, short to 47 volt ground, or an open crack sense line is detected.

There are two command modes that heat the windshield: defog and de-ice.

When defog is selected the windshield is turned on for five minutes, then off for three minutes and after that repeatedly on for three minutes off for three minutes. In De-ice mode the windshield is powered for 10 minutes and then shuts off.

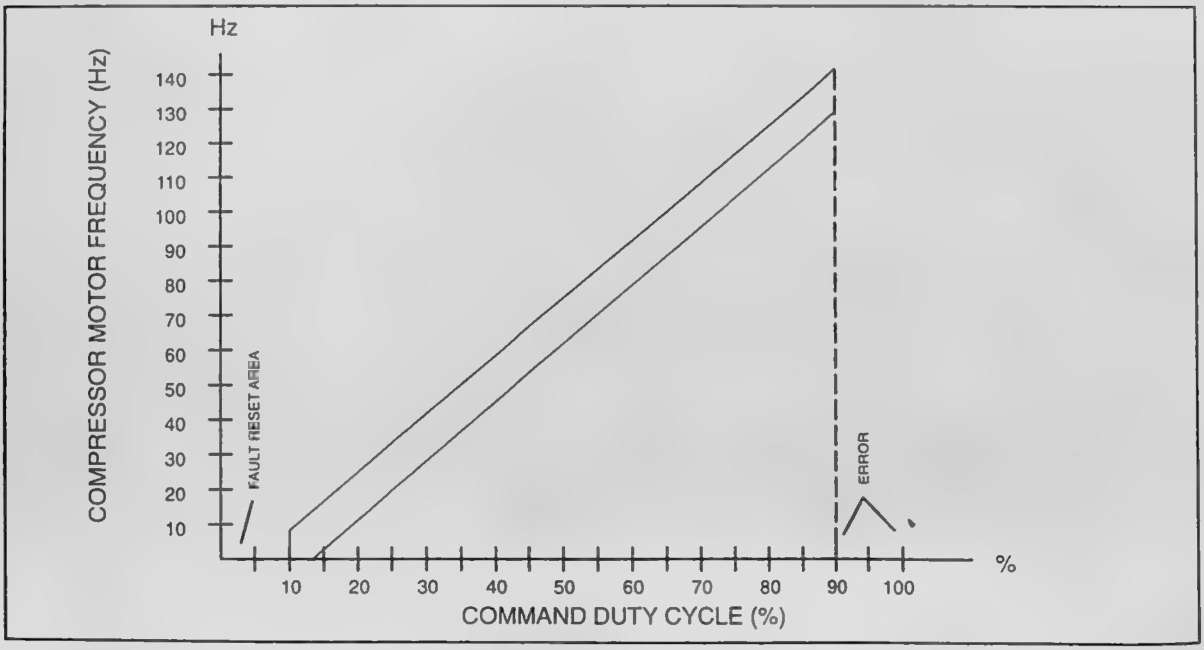
The HWS fault circuit enables the APM to detect faults in the windshield and 47 volt output/return circuits. Because the actual voltage level on the 47 volt output can vary, the feedback is always compared to the output voltage and not to an absolute voltage level. This feedback should read about 92 percent of the 47 volt signal. If the reading rises above about 96 percent or drops below about 80 percent of the 47 volt signal the APM turns off the HWS until it receives another ON command. If this occurs the APM sends a message to the HTCM indicating there is a windshield crack or circuit fault.

The APM monitors its 47 volt output circuit and sets a fault message to the HTCM if it drops below about 38 volts or rises above about 64 volts.

The 47 volt power and return lines are isolated from other APM circuits including the APM chassis ground. If the APM detects a short or partial short between either the 47 volt output or return circuit and the APM ground, the APM will lower the 47 volts to 38 (± 4 volts).

COMPRESSOR CONTROL

The APM receives a pulse width modulated (PWM) signal from the HTCM that is used to control the frequency of the three phase AC output voltage for the compressor. The output frequency varies based on the duty cycle from the HTCM as shown in the table below.



The power to the compressor is monitored and limited by the APM/PEB to help provide overload protection. The APM sends a signal to the HTCM indicating how much power the compressor motor is drawing/being fed. If an over current condition is detected the APM will limit the output power to the compressor motor.

There is an interlock circuit that runs from the APM through the compressor motor and back to the APM. Inside the compressor this loop passes through a normally closed temperature switch. If there is an open in the line due to a disconnect or an overheat in the compressor the APM turns off the power to the compressor.

APM STATUS MESSAGES AND LOAD SHED COMMAND

The APM reports to the HTCM over seven status lines;

- Three regarding APM operation and 12 volt status.
- Three regarding HWS and compressor operation and faults.
- One for the load shed command.

The state of these status lines is available over HTCM serial data.

The following tables show the state of the lines from the APM to the HTCM for the given conditions. For the APM to recognize one of the inputs as being ON the voltage on the line must be between 0 and 1 volts. For the APM to recognize one of the inputs as being OFF the line must be between 8 and 16 volts.

12 VOLT STATUS LINES

CONDITION	STATUS 2	STATUS 1	STATUS 0	HTCM CODE SET
APM disabled or APM off	ON	ON	ON	27
APM over-temperature (shutdown)	ON	ON	OFF	46
12 volt voltage > 16 volt OR 12 volt voltage < 10.5 volt and 12 volt current < 100 amps	ON	OFF	ON	37
12 volt voltage < 10.5 volt	ON	OFF	OFF	38
12 volt voltage < 13.25 volt and 12 volt current < 100 amps	OFF	ON	ON	39
12 volt current > 100 amps (maintain until current < 70 amps)	OFF	ON	OFF	NONE
Unused	OFF	OFF	ON	N/A
Normal operation	OFF	OFF	OFF	N/A

HWS AND COMPRESSOR STATUS LINES

CONDITION	STATUS 2	STATUS 1	STATUS 0	HTCM CODE SET
Cracked windshield or open windshield connector	ON	ON	ON	28
47 volt HWS isolation < 100kΩ	ON	ON	OFF	41
47 volt voltage < 45.5 volt or 47 volt voltage > 55.0 volt	ON	OFF	ON	42
47 volt: Normal operation or not requested	ON	OFF	OFF	NONE
CMC IGBT fault (shutdown compressor)	OFF	ON	ON	29 OR 30
HV input to CMC over (430 volt)/under voltage (215 volt) (shutdown compressor)	OFF	ON	OFF	31
Compressor motor interlock open due to motor overtemp or connector not engaged.	OFF	OFF	ON	32
CMC function: normal operation or not requested	OFF	OFF	OFF	NONE

IMPORTANT: The HTCM DTCs that set as a result of the APM status feedback result in a variety of actions by the HTCM depending on the failure. Refer to the appropriate DTCs in the HVAC electrical service manual for more information.

LOAD SHED COMMAND

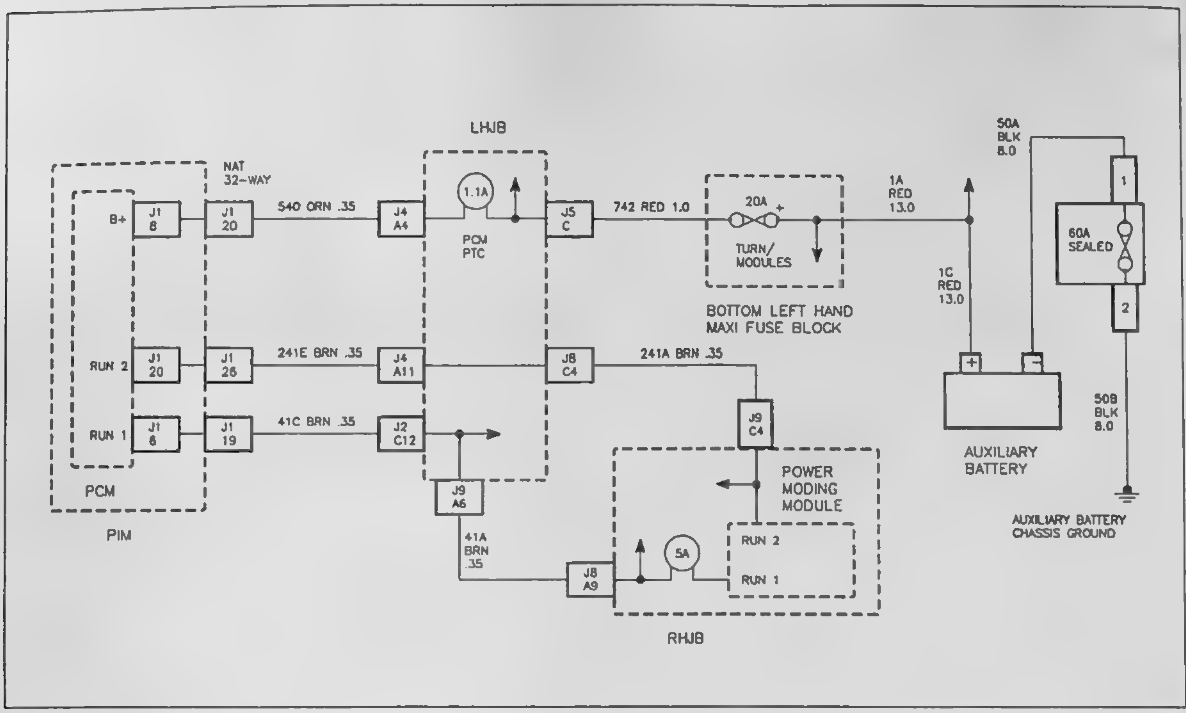
The APM will command load shed to the HTCM whenever its 12 volt output to the auxiliary battery falls below 10.5 volts and the service brake is applied. The HTCM responds to this command by turning Off power to the rear defogger and the blower for the duration of the command. Whenever a load shed command is received by the HTCM it sets a DTC 37 and sets output bit APS failure. This informs the BPM to disable the battery pack fan. Disabling these loads helps assure adequate power is available for braking. As soon as the brake is released or the 12 volt supply rises above 10.5 volts the load shed command is turned Off.

APM WAKEUP/RUN

The APM turns On when its wakeup circuit is pulled high (12 volts). The wakeup circuit can be asserted (pulled high) by the BPM, HTCM, battery recovery switch, or when the charge coupler is inserted into the charge receptacle.

The APM will also turn On when the RSA asserts Run 2 to the APM.

DTC 059 – AUXILIARY BATTERY VOLTAGE LOW



PSMELC67669AC

AUXILIARY BATTERY VOLTAGE LOW

Whenever the accessory AC and DC power control module (APM) is awake it provides a constant DC supply to the auxiliary battery which supplies power to the 12 volt systems. This DC voltage keeps the auxiliary battery charged during vehicle operation. The APM supplies voltage at two levels: 13.5 volts or 14.5 volts depending on the command from the BPM. Normal operating voltage is 13.5, but under cold weather conditions the Battery Pack Module (BPM) will command the 14.5 volts.

DTC PARAMETERS

The DTC will set when the Aux battery voltage as seen at the B+ input drops below 9 V for 250 milliseconds.

ACTION TAKEN BY THE PCM

The DTC is set, the SERVICE NOW telltale illuminated and accelerator pedal input is disabled. The fault is latched for the duration of the ignition cycle and propulsion is disabled.

RELATED DTCS

BPM 311, HTCM 38, 39

TELLTALE ILLUMINATED:

SERVICE NOW

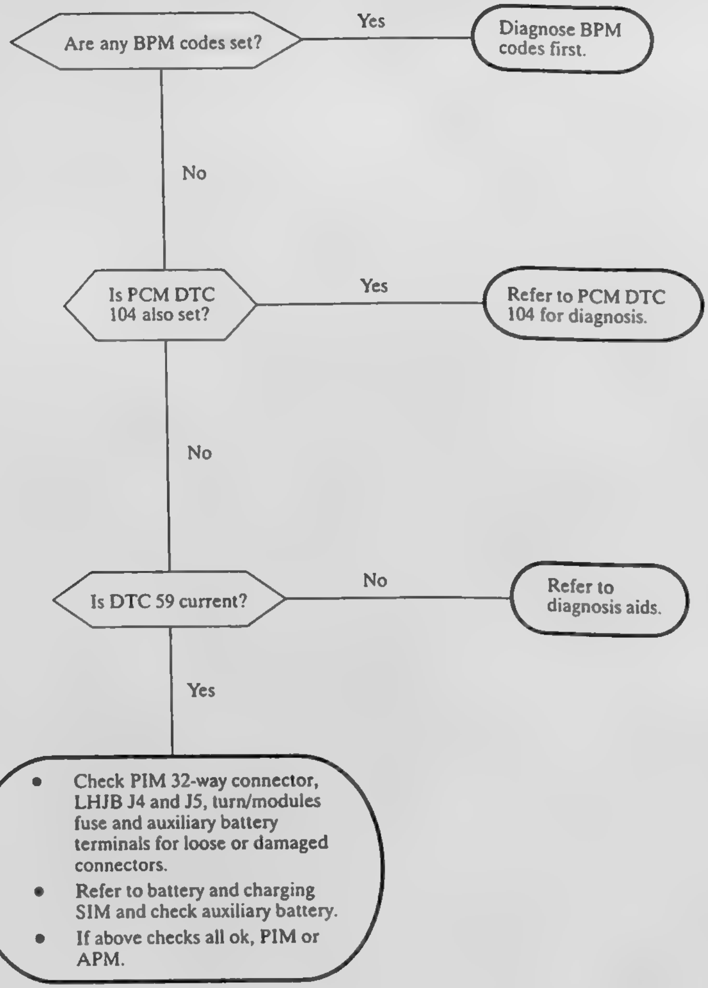
DIAGNOSTIC AIDS

- Inspect the positive and negative cables for tightness at APM and battery.
- Inspect circuit 41 for poor connections.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

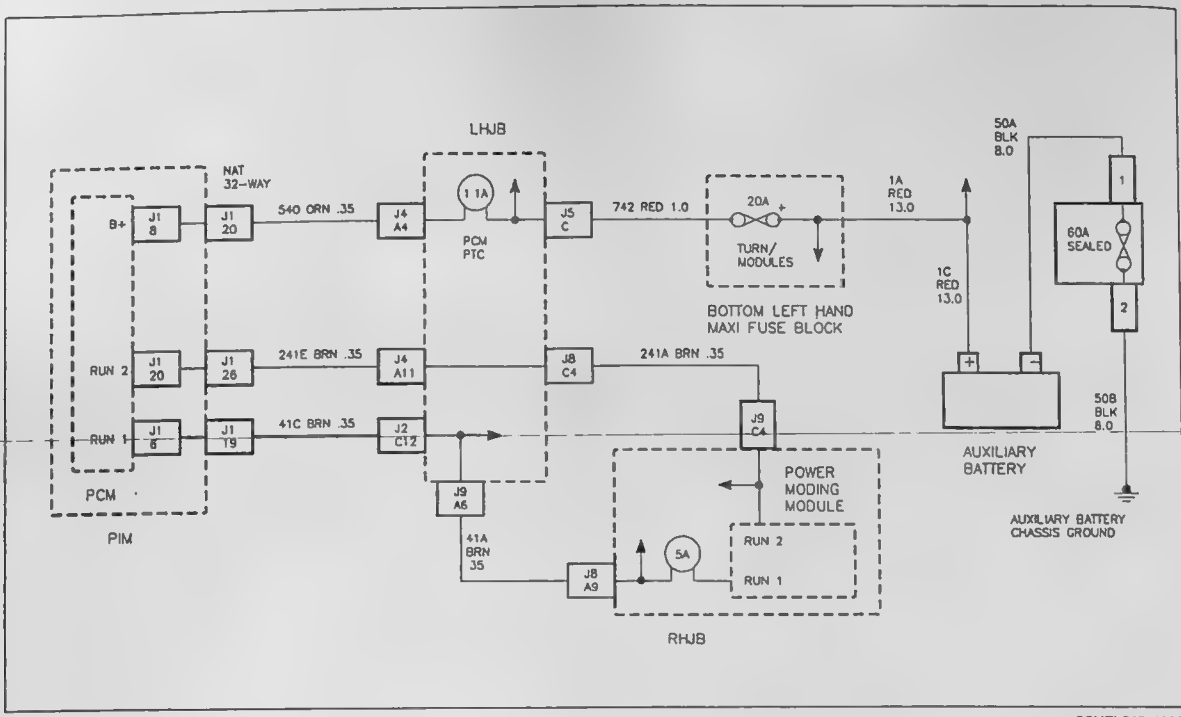
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

DTC 059
AUXILIARY BATTERY LOW VOLTAGE



DTC 060 – AUXILIARY BATTERY VOLTAGE HIGH



PSMELC67669AC

AUXILIARY BATTERY VOLTAGE HIGH

Whenever the accessory AC and DC power control module (APM) is awake it provides a constant DC supply to the auxiliary battery and supply power to the 12 volt systems. This DC voltage keeps the auxiliary battery charged during vehicle operation. The APM supplies voltage at two levels: 13.5 volts or 14.5 volts depending on the command from the battery pack module (BPM). Normal operating voltage is 13.5, but under cold weather conditions the BPM will command the 14.5 volts.

DTC PARAMETERS

The DTC will set when the Aux battery voltage as seen at the B+ input is greater than 20 V for 250 milliseconds

ACTION TAKEN BY THE PCM

The DTC is set, the SERVICE NOW telltale is illuminated and accelerator pedal input is disabled. The fault is latched for the duration of the ignition cycle and propulsion is disabled.

RELATED DTCS

BPM 310, HTCM 37, 39, 40

TELLTALE ILLUMINATED:

SERVICE NOW

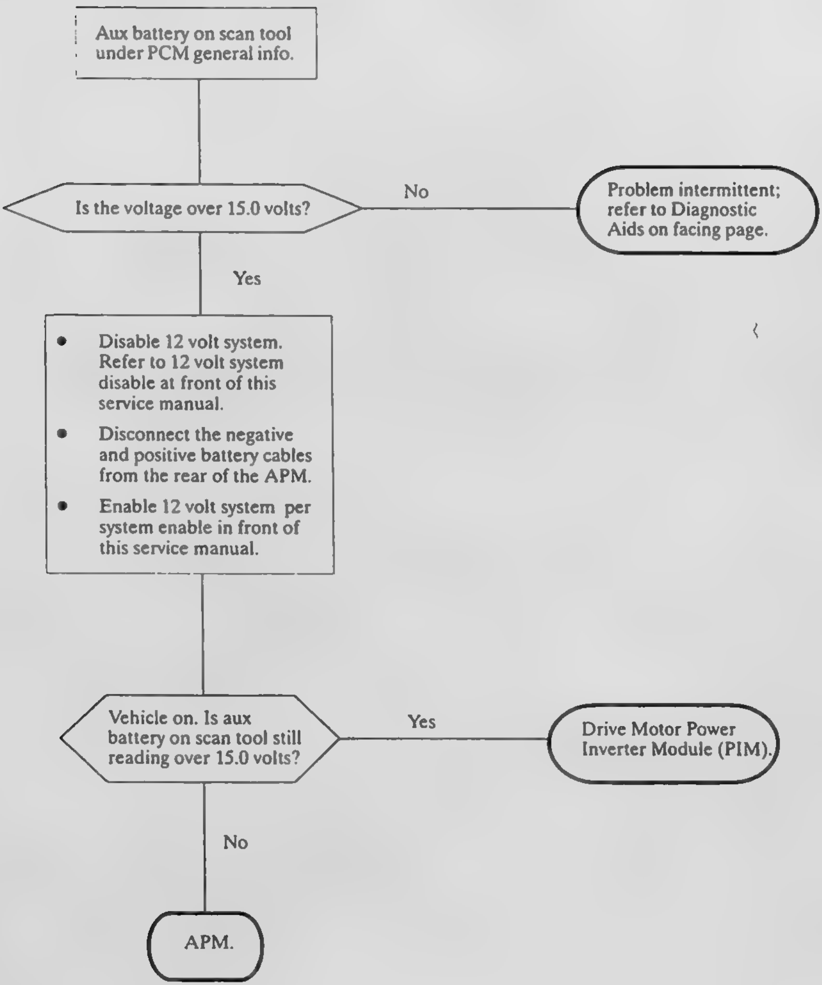
DIAGNOSTIC AIDS

- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

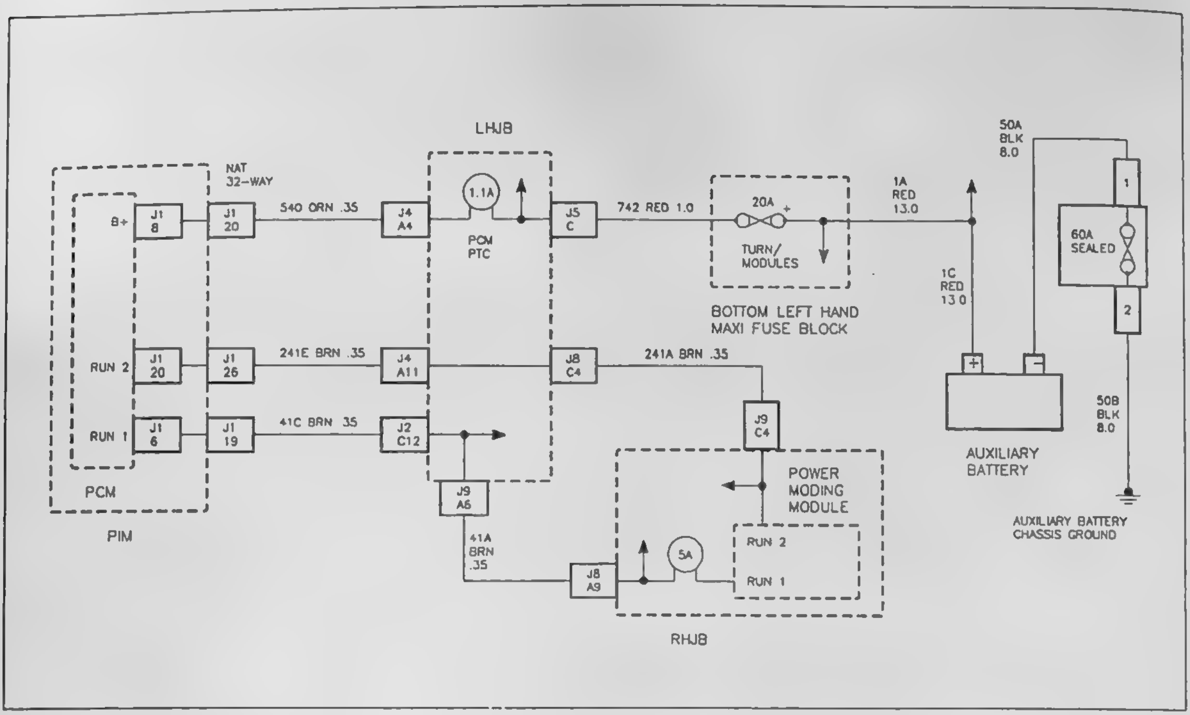
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

DTC 060
AUXILIARY BATTERY VOLTAGE HIGH



DTC 104 – AUXILIARY BATTERY NOT CHARGING



PSMELC67669AC

AUXILIARY BATTERY NOT CHARGING

Whenever the accessory AC and DC power control module (APM) is awake it provides a constant DC supply to the auxiliary battery and supply power to the 12 volt systems. This DC voltage keeps the auxiliary battery charged during vehicle operation. The APM supplies voltage at two levels: 13.5 volts or 14.5 volts depending on the command from the battery pack module (BPM). Normal operating voltage is 13.5, but under cold weather conditions the BPM will command the 14.5 volts.

DTC PARAMETERS

This DTC will set any time the vehicle is in the Run mode and auxiliary battery voltage read by the PCM at the B+ input is less than 12.5 volts for 30 seconds.

ACTION TAKEN BY THE PCM

The DTC is set, and the SERVICE NOW telltale is illuminated. If the problem is intermittent and clears itself the telltale will turn Off after 10 seconds.

RELATED DTCS

BPM 311, HTCM 37, 38, 39

TELLTALE ILLUMINATED:

SERVICE NOW

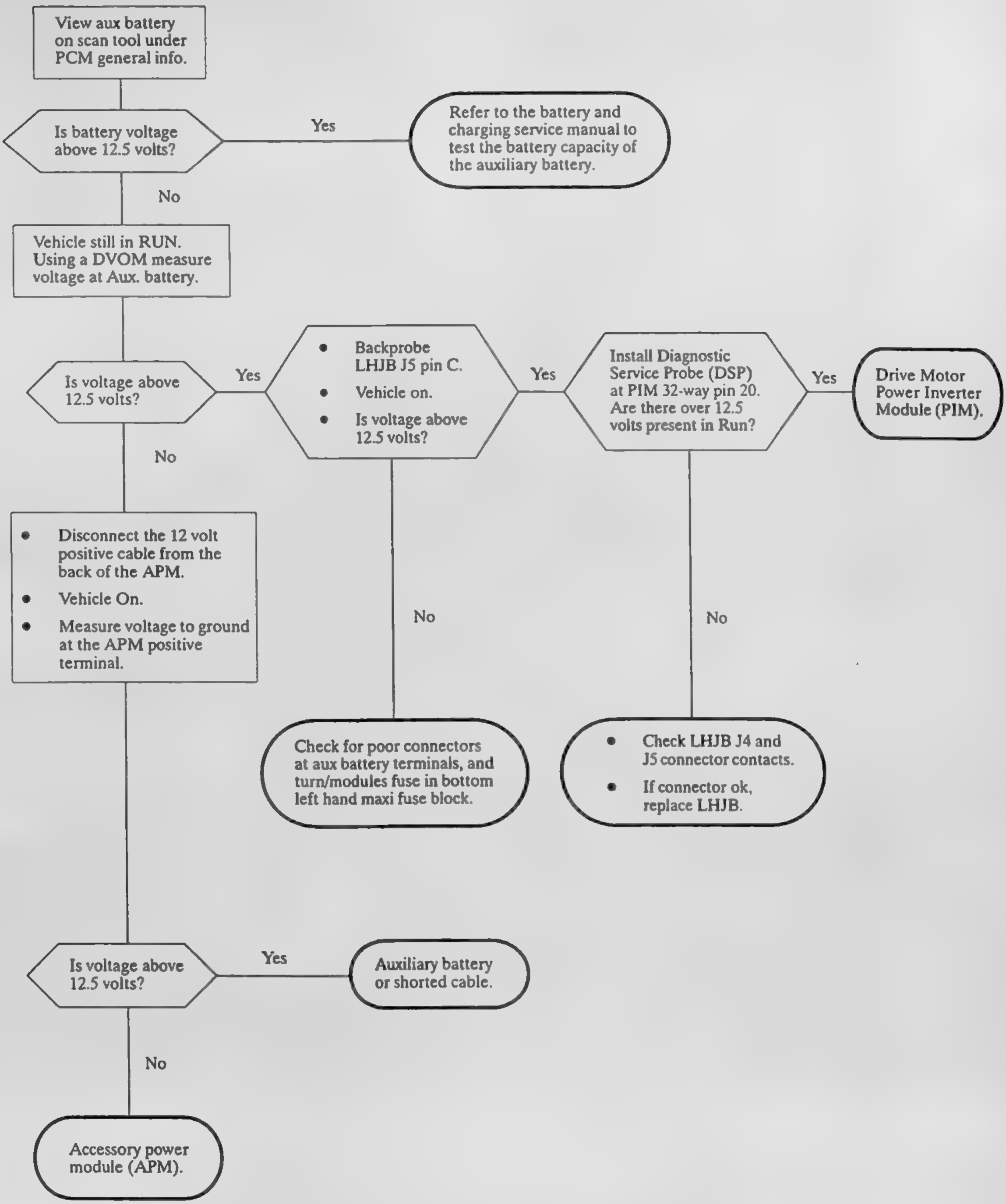
DIAGNOSTIC AIDS

- Check positive and negative cables for tight connections.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfuncton History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

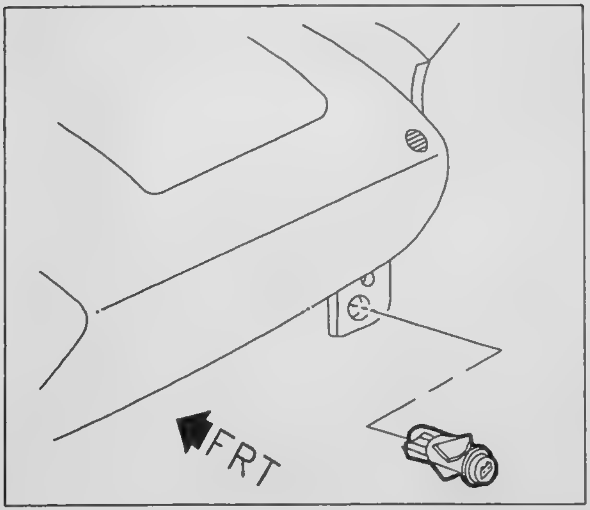
DTC 104
AUXILIARY BATTERY NOT CHARGING



AUXILIARY BATTERY RECOVERY IN VEHICLE

If the vehicle will not power up normally due to a discharged aux battery the battery recovery switch (button) can be used to power up the vehicle. The battery recovery switch is supplied 12 volts from the auto disconnect power supply. The auto disconnect power supply is located in the battery pack. The auto disconnect takes the pack voltage as an input to create a 12 volt power supply for the auto disconnect operation. As long as the battery pack voltage is above 180 volts and the battery pack module (BPM) has not commanded the HV relays open the Auto Disconnect system will function and provide 12 volts to the battery recovery switch.

When the switch is depressed the 12 volt signal is connected to the vehicle wakeup line. This allows the accessory AC and DC power control module (APM) to turn On and provide charge power to the Aux battery and 12 volts to the 12 volt systems. To use the battery recovery switch (button) follow the following procedure:



PSMELC65992AA

BATTERY RECOVERY PROCEDURE

1. Locate the battery recovery switch – it is located on the passenger side of the vehicle under the instrument panel to the far right. The button has a picture of a battery.
2. Momentarily press and release the battery recovery switch.
3. Wait 30 seconds.
4. Press and hold the battery recovery switch for three seconds, then release the button.
5. Enter your run/lock shifter assembly (RSA) key code and press Run restoring the system.

ACCESSORY AC AND DC POWER MODULE (APM)

REMOVAL

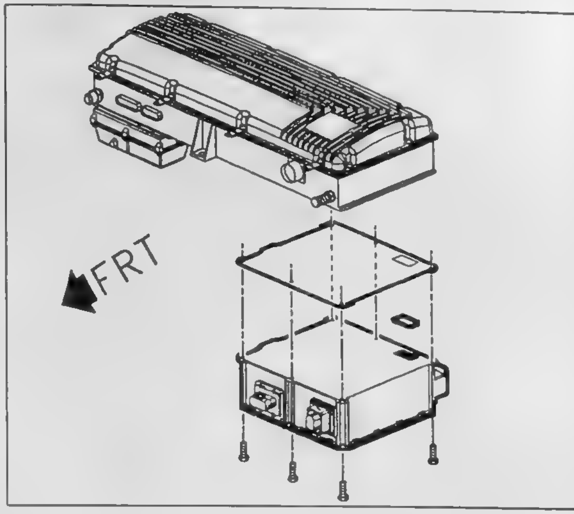
1. Remove the power electronics bay (PEB). (Refer to the "PEB Removal" procedure in the front of this manual.)
2. With the PEB removed, turn the PEB over onto a soft surface to prevent scratching or damaging the PEB cover.
3. Remove the six APM to PIM screws.
4. Carefully lift the APM straight up from the PIM until the connector is disconnected and set upright.
5. Remove the APM gasket and clean the gasket surface on both the PIM and the APM with alcohol. The gasket must be replaced.
6. Remove the O-ring seal from the APM to PIM connector cavity.

INSTALLATION

1. Make sure the APM and PIM gasket surfaces are clean and dry. Properly align new gasket on the PIM mating surface.
2. Install new connector O-ring.
3. Position the APM above the PIM connector and carefully lower APM onto PIM connector.
4. Install the six APM to PIM screws and evenly tighten the screws and torque.

Torque: 6 N·m (50 in−lbs)

5. Install the PEB. (Refer to the "PEB Installation" procedure in the front of this manual.)

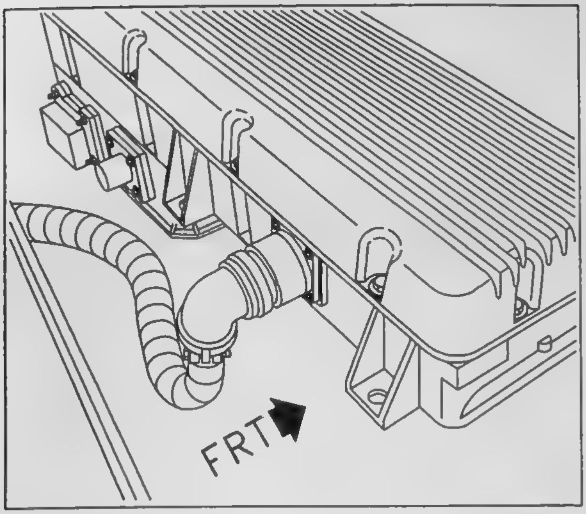


PSNHVC87059AA

AUXILLARY BATTERY

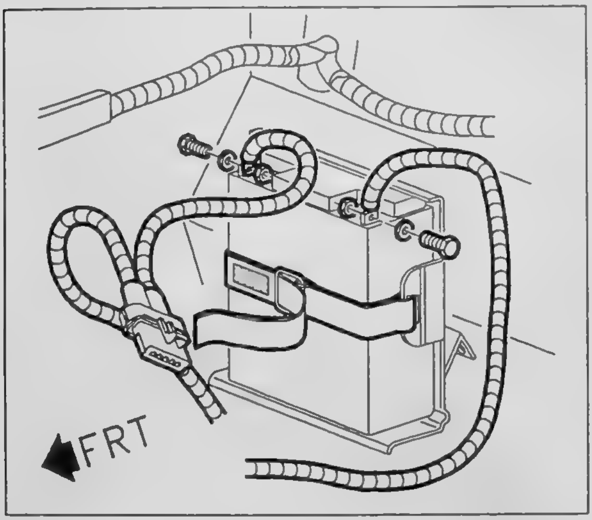
REMOVAL

1. Disable high voltage. (Refer to "High Voltage" disable procedure in this manual.)
2. Disable 12 volt system. (Refer to "12 Volt System" disable procedure in this manual.)
3. Remove the battery pack cannon connector and position out of the way.



PSMPEN66279AA

4. Lift the boot to expose positive terminal on the drivers side of battery.
5. Using a T25 TORX™ and a 8 mm wrench or socket remove the bolt and cable from the terminal.
6. Disconnect the Velcro® strap by pulling up and through the metal retainer.
7. Pull the aux battery forward and up to disconnect the battery from the velcro at the bottom of the battery.
8. Turn the battery counter clockwise to access the passenger side, negative terminal.
9. Lift the boot on the left terminal and remove the bolt and cable from the terminal.
10. Carefully lift the battery between the PIM and the front of dash.

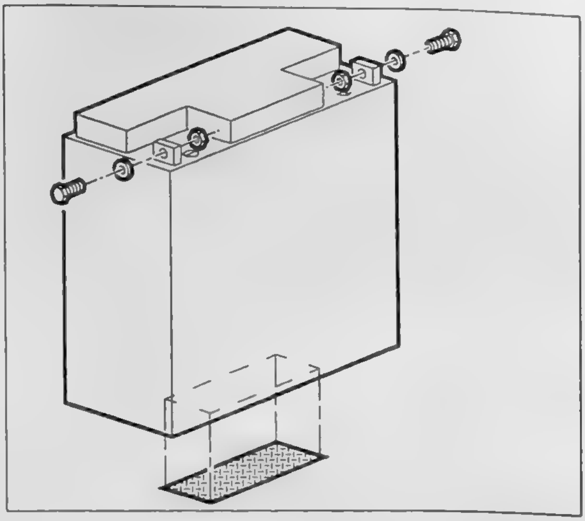


PSMPEN66663AA

INSTALLATION

1. If installing a new battery make sure the velcro strip is installed on the back of the battery.
2. Carefully slide the battery between the PIM and the front of dash.
3. Rotate the battery and install the negative cable to the battery and push the boot down over the terminal.

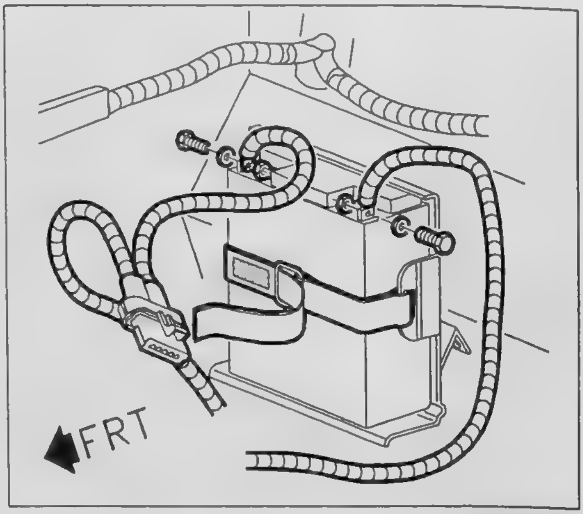
Torque: 6 N•m (53 in-lbs)



PSMPEN66665AB

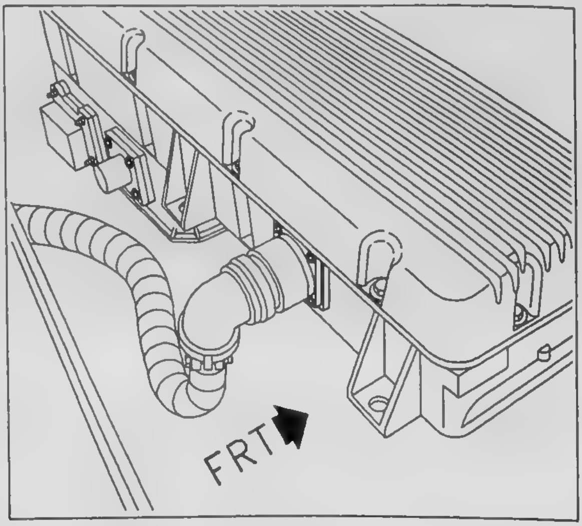
4. Place the battery in the bracket and fasten the velcro strap.
5. Install the positive cable to the battery and push the boot down over the terminal.

Torque: 6 N•m (53 in-lbs)



PSMPEN66663AA

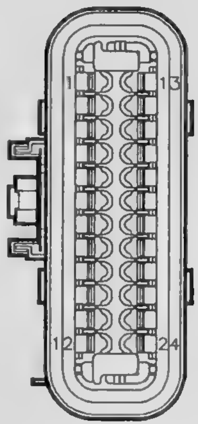
6. Install the battery pack cannon connector.
7. Enable 12 volt system. (Refer to "12 Volt System Enable" procedure in this manual.)
8. Enable high voltage. (Refer to "High Voltage Enable" procedure in this manual.)



PSMPEN66279AA

HARNESS CONNECTOR FACES

ACCESSORY AC AND DC POWER MODULE (APM)



NATURAL
12129225

Location: Underhood, Left Side of Accessory Power Module

PSMELC67235AA

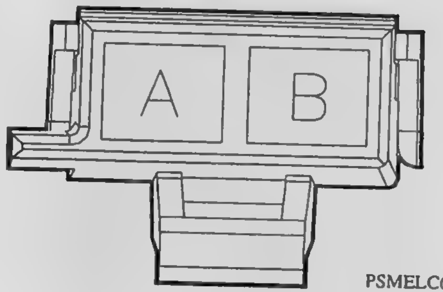
ACCESSORY AC AND DC POWER MODULE – 12129225

CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
1	BRN	241B	.35	RUN 2
2	WHT	249	.35	AUX POWER SUPPLY (APS) COMMAND IN
3				
4	BLK/WHT	1085	.35	CMC SPEED COMMAND IN
5	RED	1262	.35	APM 12V STATUS BIT 0
6	PPL	1645	.35	BRAKE LOAD SHED
7	ORN	1263	.35	APM 12V STATUS BIT 1
8	PNK/BLK	1217	.35	CMC DC CURRENT
9	DR GRN	1264	.35	APM 12V STATUS BIT 2
10				
11				
12				

CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
13	YEL	820C	.35	BRAKE SWITCH IN
14				
15	WHT	637	.35	HEATED W/S COMMAND IN
16				
17				
18	DK BLU	1081	.35	CMC/47V STATUS BIT 0
19	YEL	1082	.35	CMC/47V STATUS BIT 1
20	PPL	1083	.35	CMC/47V STATUS BIT 2
21				
22				
23				
24	WHT	2027C	.35	VEHICLE WAKE-UP

HARNESS CONNECTOR FACES

BATTERY RECOVERY SWITCH (BRS)



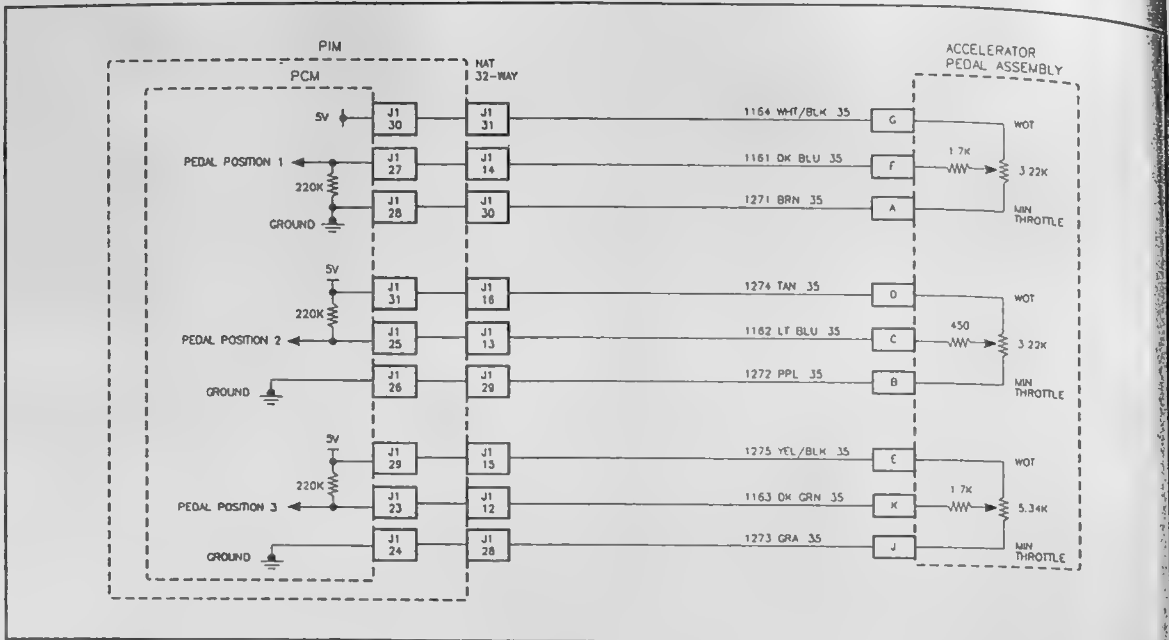
PSMELC67223AA

GRAY
12034341

BATTERY RECOVERY SWITCH – 12034341				
CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
A	LT BLU	26C	.35	AD POWER SUPPLY
B	WHT	2027E	.35	VEHICLE WAKE–UP

Location: Passenger Compartment, Under Right Side of I/P

DTC 100 – 5 VOLT OUTPUT TO PEDAL POSITION SENSOR 3 LOW



PSMELC67654AC

5 VOLT OUTPUT TO PEDAL POSITION SENSOR 3 LOW

The accelerator pedal assembly (APA) consists of three potentiometers which provide voltages proportional to the pedal position. All three sensors have 5 volt sources which are independent. Sensors 2 and 3 are inverted by the PCM of actual reading 0 = 5 volts. Sensor 1 varies from 0.6 volts at closed position to about 4.5 volts at wide open throttle (WOT). Sensor 2 varies from about 4.3 volts at closed position to about 0.5 volts at (WOT). Sensor 3 varies from 4.0 volts at closed position to about 1.7 volts at (WOT).

DTC PARAMETERS

This DTC will set anytime the PCM reads less than 3.5 volts for 16 milliseconds.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC set.

RELATED DTCS

PCM 98

TELLTALE ILLUMINATED:

SERVICE SOON

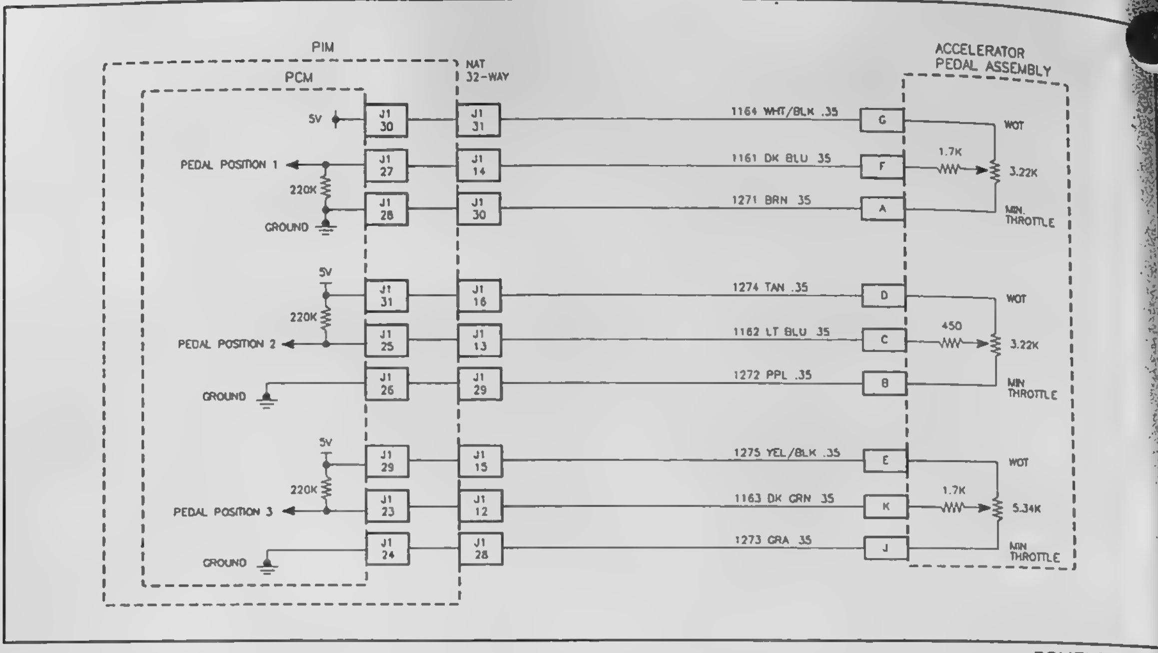
DIAGNOSTIC AIDS

- The slope of each sensor is different, which enables identification of which potentiometer has failed. Pedal positon sensors 2 and 3 are pulled high. Sensor 1 is pulled low.
- All three pedal position sensors have 5 volt sources which are independent. Pedal position sensors 2 and 3 are inverted of actual reading 0 = 5 volts.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

DTC 101 – 5 VOLT OUTPUT TO PEDAL POSITION SENSOR 3 HIGH



PSMELC67654AC

5 VOLT OUTPUT TO PEDAL POSITION SENSOR 3 HIGH

The accelerator pedal assembly (APA) consists of three potentiometers which provide voltages proportional to the pedal position. All three sensors have 5 volt sources which are independent. Sensors 2 and 3 are inverted by the PCM of actual reading 0 = 5 volts. Sensor 1 varies from 0.6 volts at closed position to about 4.5 volts at wide open throttle (WOT). Sensor 2 varies from about 4.3 volts at closed position to about 0.5 volts at (WOT). Sensor 3 varies from 4.0 volts at closed position to about 1.7 volts at (WOT).

DTC PARAMETERS

This DTC will set anytime the PCM reads more than 5.4 volts for 16 milliseconds.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC set.

RELATED DTCS

PCM 99

TELLTALE ILLUMINATED:

SERVICE SOON

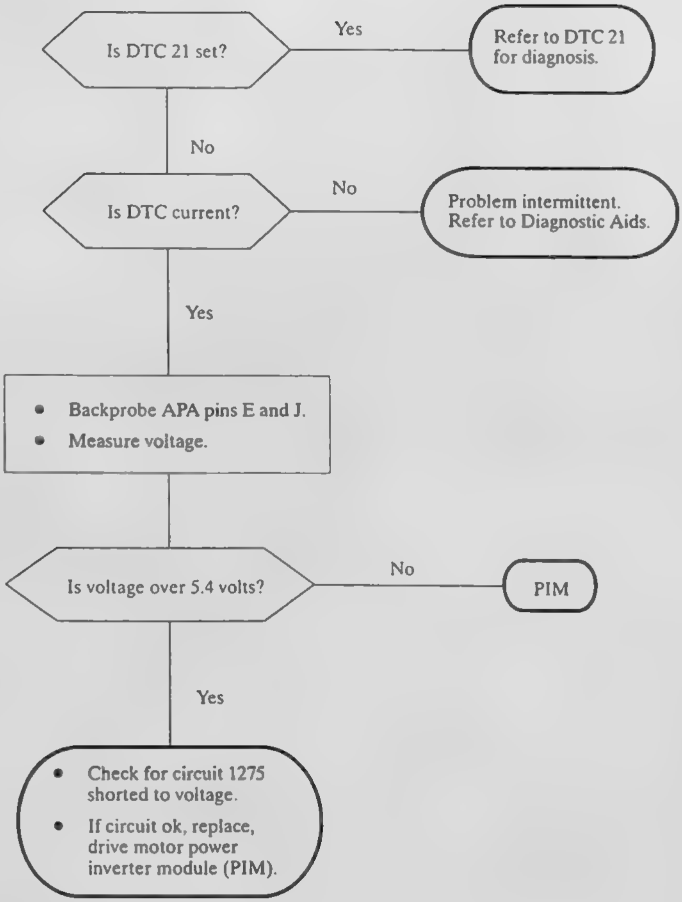
DIAGNOSTIC AIDS

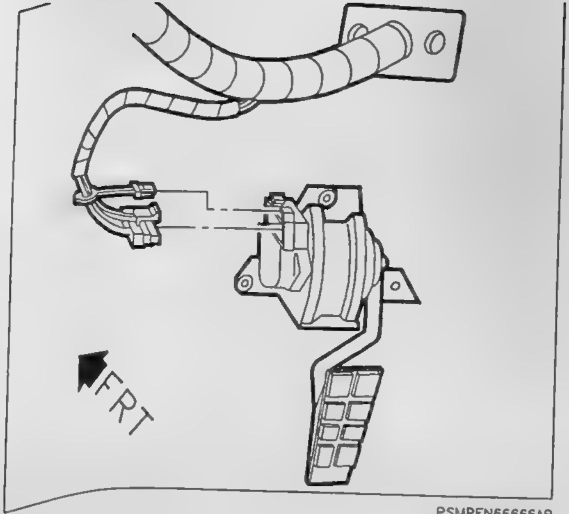
- The slope of each sensor is different, which enables identification of which potentiometer has failed. Pedal position sensors 2 and 3 are pulled high. Pedal position sensor 1 is pulled low.
- All three pedal position sensors have 5 volt sources which are independent. Pedal position sensors 2 and 3 are inverted of actual reading 0 = 5 volts.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

DTC 101
5 VOLT OUTPUT TO PEDAL POSITION 3 HIGH





PSMPEN66666A8

ACCELERATOR PEDAL ASSEMBLY (APA)

REMOVAL

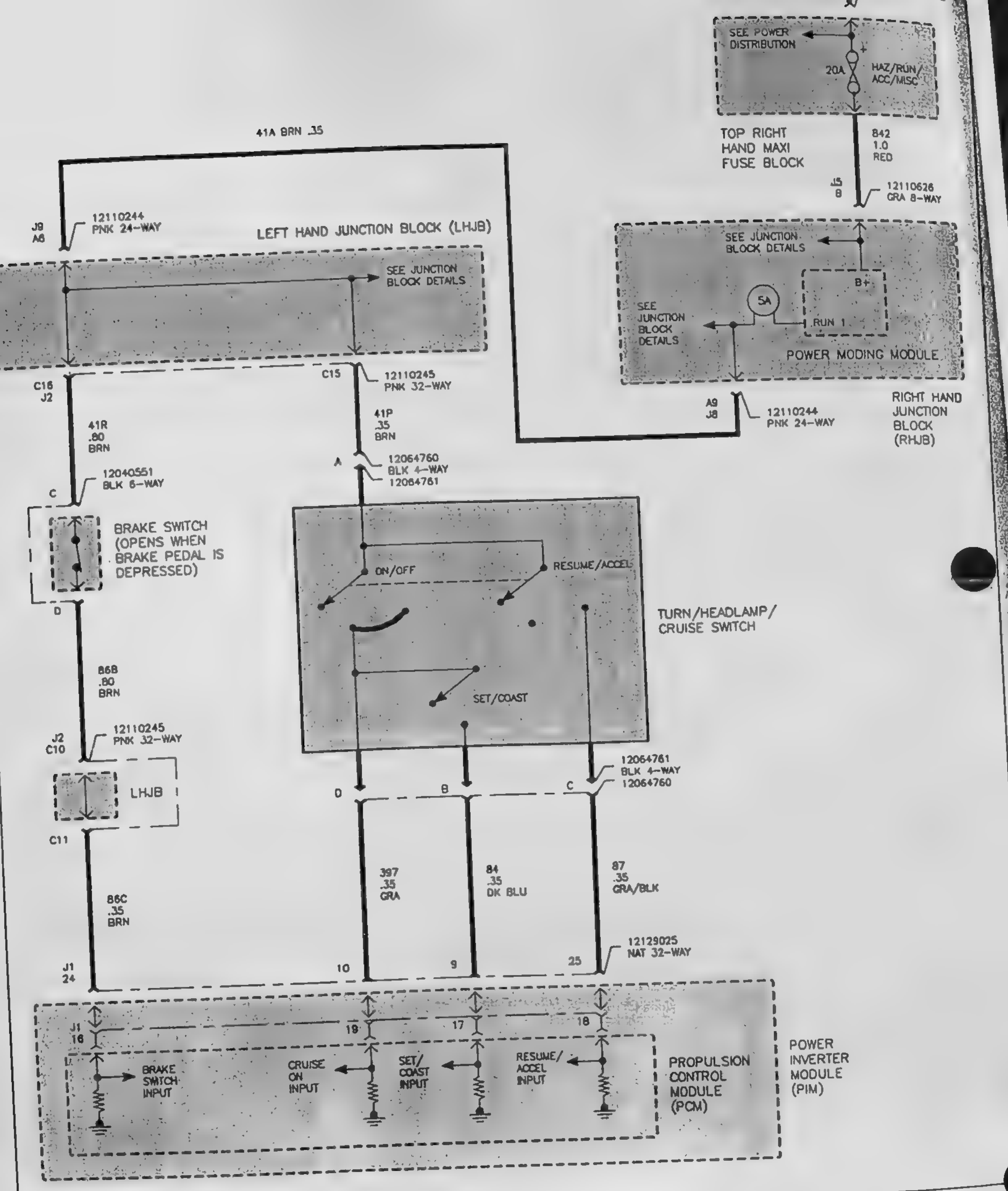
1. Remove connector position assurance (CPA).
2. Disconnect APA connector.
3. Remove APA bolts.
4. Remove APA.

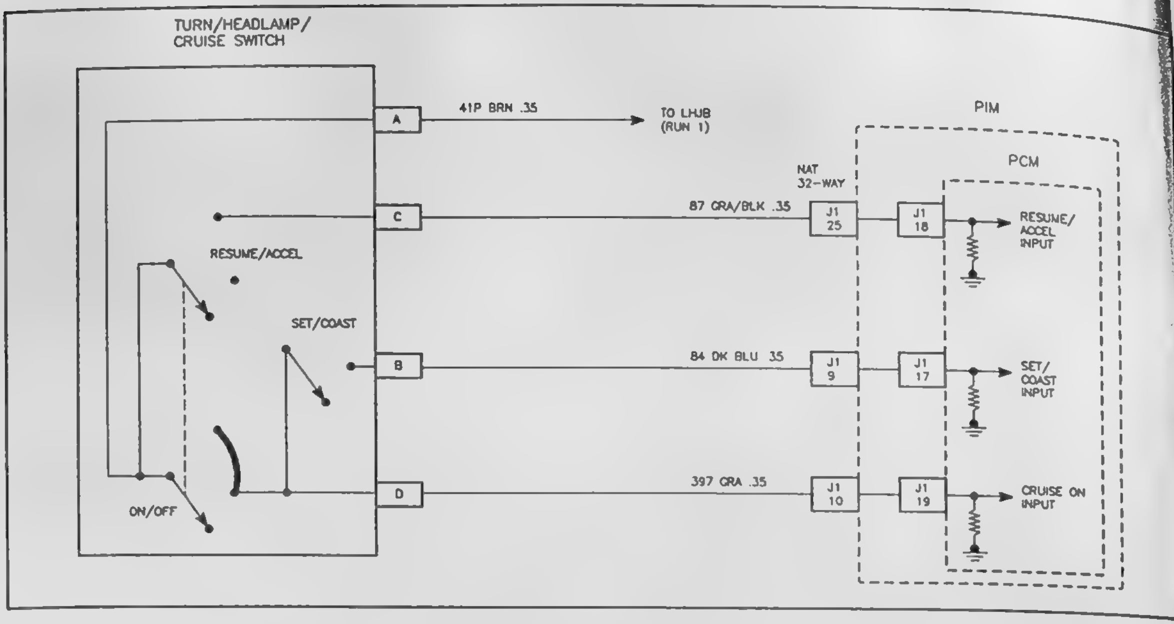
INSTALLATION

1. Install APA.
2. Install APA bolts.

Torque: 8 N•m (71 in–lbs)

3. Connect wiring harness to APA.
4. Install CPA.


SEE POWER DISTRIBUTION
20A
HAZ/RUN/ACC/MISC
TOP RIGHT HAND MAXI FUSE BLOCK
842
1.0
RED
J5
B
12110626
GRA 8-WAY
41A BRN .35
J9
A6
12110244
PNK 24-WAY
LEFT HAND JUNCTION BLOCK (LHJB)
SEE JUNCTION BLOCK DETAILS
SEE JUNCTION BLOCK DETAILS
B+
5A
SEE JUNCTION BLOCK DETAILS
RUN 1
POWER MODING MODULE
C16
J2
C15
12110245
PNK 32-WAY
41P
.35
BRN
A9
J8
12110244
PNK 24-WAY
RIGHT HAND JUNCTION BLOCK (RHJB)
41R
.80
BRN
A
12064760
BLK 4-WAY
12064761
C
12040551
BLK 6-WAY
BRAKE SWITCH (OPENS WHEN BRAKE PEDAL IS DEPRESSED)
ON/OFF
RESUME/ACCEL
D
TURN/HEADLAMP/ CRUISE SWITCH
86B
.80
BRN
SET/COAST
J2
C10
12110245
PNK 32-WAY
LHJB
D
B
C
12064761
BLK 4-WAY
12064760
C11
397
.35
GRA
84
.35
DK BLU
87
.35
GRA/BLK
86C
.35
BRN
12129025
NAT 32-WAY
J1
24
10
9
25
J1
16
19
17
18
BRAKE SWITCH INPUT
CRUISE ON INPUT
SET/ COAST INPUT
RESUME/ ACCEL INPUT
PROPULSION CONTROL MODULE (PCM)
POWER INVERTER MODULE (PIM)



PSMELC67663AA

CRUISE ON/OFF INVALID AT POWER DOWN

The propulsion control module (PCM) reads three cruise control switch inputs: set/coast, resume/accel, and On/Off. These switches are powered off of switched 12 V so that they are forced low when IGN 1 is low. The PCM checks the state of these switches at power down in order to ensure that they are all low after IGN 1 has gone low.

DTC PARAMETERS

The DTC will set when the cruise On/Off switch is above 3.5 volts after IGN 1 has gone below 2.0 volts at power down.

ACTION TAKEN BY THE PCM

The DTC is set and cruise control is disabled for the ignition cycle.

RELATED DTCS

None

TELLTALE ILLUMINATED:

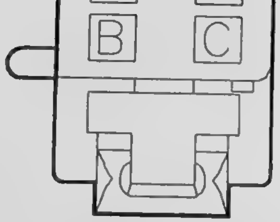
None

DIAGNOSTIC AIDS

- If condition is intermittent check circuit 397 for damage between the PIM 32-way pin 10 and the cruise switch pin D that could cause it to short to voltage intermittently.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the code sets.



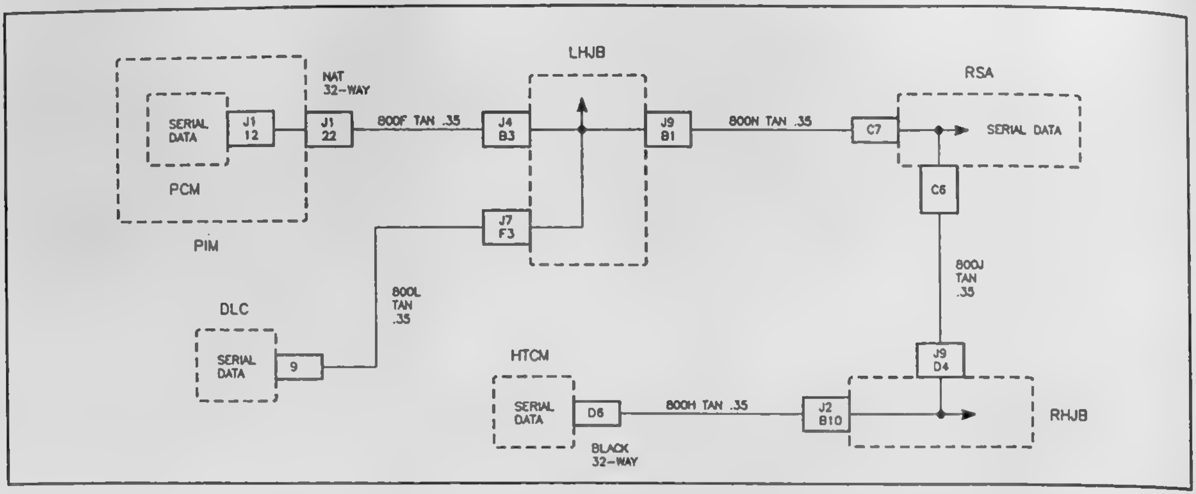
PSMELC67264AA

BLACK
12064760

B	DK BLU	84	.35	SET/COAST OUT
C	GRA/BLK	87	.35	RESUME/ACCEL OUT
D	GRA	397	.35	ON/OFF OUT

Location: Passenger Compartment, Attached to Steering Column

DTC 029 – HEAT PUMP THERMAL CONTROL MODULE (HTCM) SERIAL DATA LOSS



PSMELC67658AA

HEAT PUMP THERMAL CONTROL MODULE (HTCM) SERIAL DATA LOSS

The serial data line is used to transmit data between the PCM and HTCM during normal operation. If the PCM does not receive valid data from the HTCM it will operate on substitute default data.

DTC PARAMETERS

The DTC will set any time the PCM has not received valid data from the HTCM for 36 seconds

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC will be stored. The PCM will substitute a default set of data after the first 6 seconds of serial data loss. If the fault is intermittent and clears itself, the telltale will turn Off after 10 seconds and the PCM will return to normal operation.

RELATED DTCS

All serial data codes.

TELLTALE ILLUMINATED:

SERVICE SOON

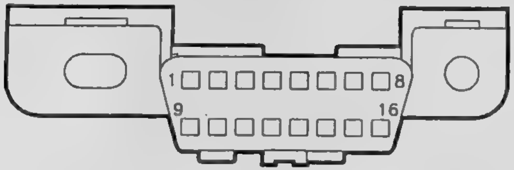
DIAGNOSTIC AIDS

- Receives information from HTCM: Default Values
  Service soon request = Off
  HTCM regen disable = Not Disabled
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the code sets.

DATA LINK CONNECTOR (DLC)



PSMELC67259AA

GRAY
12110250

DATA LINK CONNECTOR – 12110250				
CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
1				
2	PPL	1807C	.35	CLASS 2 DATA
3				
4	BLK	450N	.35	GROUND
5	BLK	450T	.35	GROUND
6				
7				
8				
9	TAN	800L	.35	SERIAL DATA
10				
11				
12				
13				
14				
15				
16	ORN	1640	.35	B+

Location: Passenger Compartment, Under Lower Left of I/P

REGENERATIVE BRAKING

BRAKING PERFORMANCE SUBSYSTEM

When the brake is applied, the brake torque control module (BTCM) will request a certain amount of assistance from the drive motor to slow the vehicle. This is accomplished by a request to the PCM who in turn calculates based on inputs the amount of allowable regeneration (negative torque) it will request from the drive motor.

The PCM calculates accelerator pedal torque based on vehicle and driver inputs. When a request for retard/regen is received by the PCM it takes the sum of the accelerator pedal torque and the retard/regen request. The retard/regen request will be a negative number. The sum will provide the net torque. The net torque is used to create the value of slip sent to the bias control assembly (BCA) which controls the motor current. If the result is positive acceleration, force is applied to the motor in the forward direction. If the result is negative, braking of the motor will occur.

If the rotor and stator fields are lined up zero torque is being applied. To move the rotor the stator field moves ahead and stays ahead of the rotor pulling it around in a circle. The stator field is a direct result of the slip command. When retard is requested the stator field starts to move back towards the rotor reducing the torque to zero. If Regen is requested the stator field actually starts to move in the reverse direction causing braking of the motor. When the vehicle reaches about 10 km/h (6 mph) regen will be disabled to prevent the motor from turning in the opposite direction.

The PCM receives inputs from the braking subsystem to control regenerative current output from the drive motor to the battery pack. The power inverter module (PIM) uses battery pack status, retard request, PRND mode, shaft rate and direction to calculate the maximum possible Propulsion brake torque.

- The braking subsystem outputs to the PIM: Retard request
Disable regeneration
Service brake switch
park brake switch
- The BPM outputs to PIM: PSOC
Pack voltage

The PIM will report back to the braking subsystem the Retard Achieved Status. The PCM uses the Service Brake input during cruise operation to disable cruise control.

RETARD

The BTCM sends a retard request to the PCM via a discreet line and over serial data. The retard request is sent by the BTCM during braking to reduce brake wear and if the front tires are slipping for traction control. If the BTCM determines the front tires are stuck, it will request positive retard, which increases the torque to get the front tires moving.

The PCM will calculate a reduced propulsion torque value based on the retard request value. The maximum retard available is equal to the propulsion torque at the time of retard request. Maximum retard can cause only a net zero torque. Negative torque is considered Regen torque.

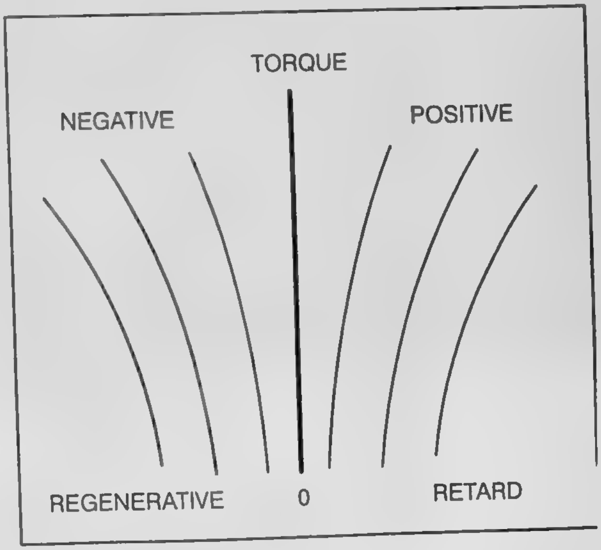
REGENERATION

The PIM provides a regeneration function that allows the drive motor to supply negative shaft torque, which assists in slowing down the vehicle. In this mode the drive motor and PIM act as a generator providing current to charge the battery pack.

Regen torque will be inhibited if:

- PRND is in park or neutral
- Discrete regen disable is active
- Redundant (serial) regen disable is active
- Manual disconnect is open
- Pack voltage fault has occurred
- PSOC is equal to 100%. The amount of negative torque requested is a function of the PSOC of the battery pack. If the PSOC is high the amount of regen will be low.

The maximum allowed regeneration is 365 volts DC and 30 amps DC.



BTCM

When the BTCM requires the motor to reduce the torque for braking it increases the retard request PWM signal duty cycle. The BTCM does not know if the motor is doing retard or regen. The PCM takes the signal and sums it with accelerator torque (also takes into account the other slip variables) to send out a final torque Slip command.

The BTCM is capable of performing full braking if Regen cannot be achieved by the drive motor. In milliseconds the BTCM knows how much braking is required, based on the amount of achievable regen the PCM reports back to the BTCM.

During normal deceleration with no brake input, regen torque as a function of drive motor speed will slow the motor down. This is called the drag function. If during this time the BTCM starts to see wheel slip it will reduce the regen or retard request to reduce the amount of regen torque to stop the wheel slip.

INPUTS AND OUTPUTS

There are three signal lines for retard/regen operation plus a serial data copy of the discrete lines. The retard request line uses a duty cycle signal between 10 percent to 90 percent which is sent by the BTCM to the PCM. The PCM uses this value to calculate a net torque for the drive motor.

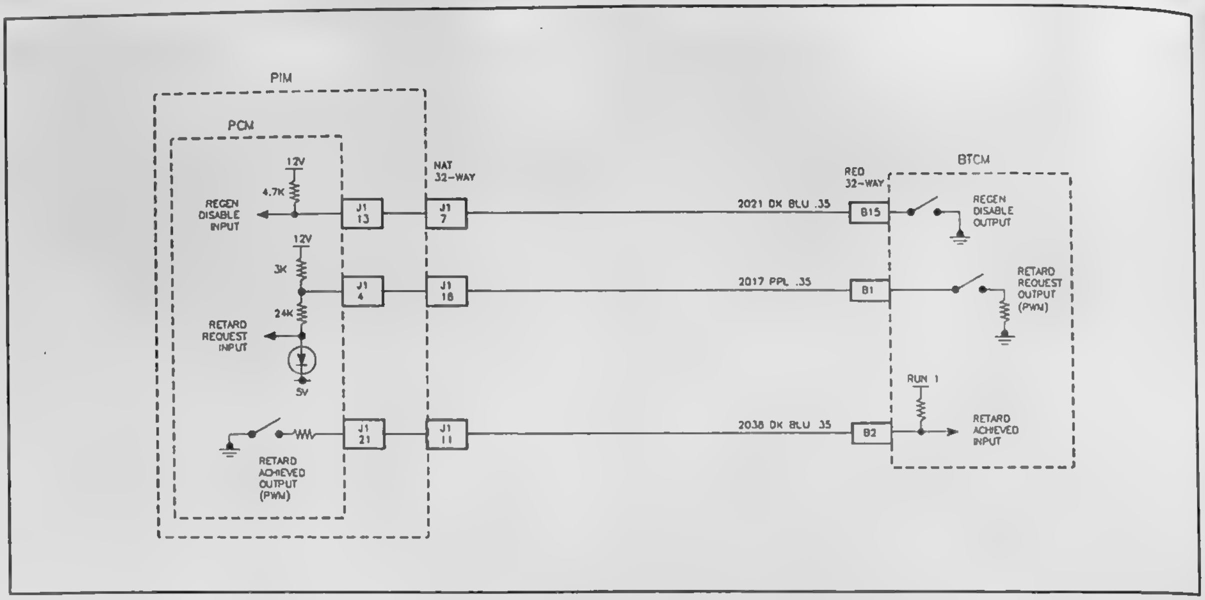
10%–18% – Reduces the amount of drag on the motor. (Positive torque)

18% – No retard or regen request.

18%–90% – Retard or Regen to slow vehicle down. (Negative torque)

Retard Achieved: This line is used by the PCM to report to the BTCM the amount of retard/regen achieved by the Drive Motor.

Regen disable: Regen disable is used by the BTCM to disable all retard/regen. This happens during ABS braking when regen is ramped down and then turned Off.



PSMELC67653AB

REGEN DISABLE STUCK LOW

The brake torque control module (BTCM) requests regen disable via a discrete input and also by serial data. If the discrete input disagrees with the serial data, the propulsion control module (PCM) will set the DTC.

DTC PARAMETERS

The DTC will set anytime the BTCM and PCM are communicating on serial data and the discrete input is less than 2.5 volts but serial data indicates a high.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated, the DTC set and regen will be disabled. The DTC will latch until the next power-up and clear if the condition is not present.

RELATED DTCS

None

TELLTALE ILLUMINATED:

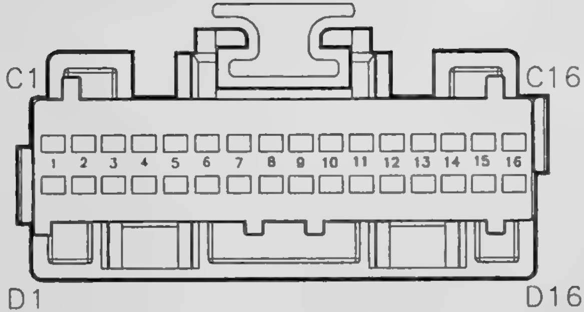
SERVICE SOON

DIAGNOSTIC AIDS

- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

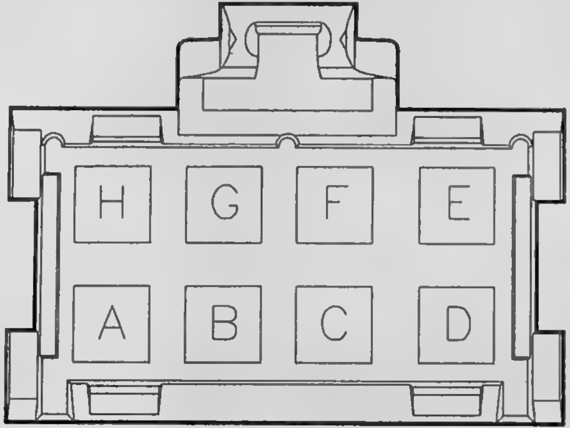


DK RED
12110113

mpartment, Under Left Side of I/P

PSMELC66035AA

BRAKE TORQUE CONTROLLER MODULE (BTCM) – J2

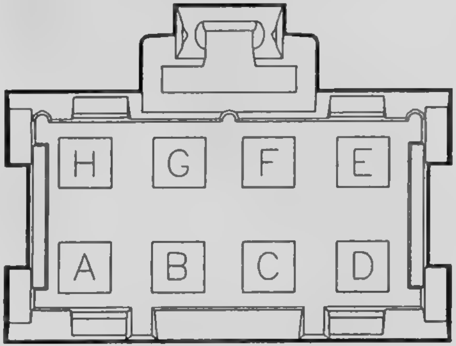


LT GRAY

BRAKE TORQUE CONTROLLER MODULE – J2 – 12110626				
CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
A	WHT	2001	.80	LR PARK MOTOR HI OUT
B	TAN	2003	.80	LR PARK MOROR LO OUT
C	TAN	2004	.80	RR PARK MOTOR LO OUT
D	YEL	2007	.80	LR APPLY MOTOR LO OUT
E	LT BLU	2005	.80	LR APPLY MOTOR HI OUT
F	DK GRN	2006	.80	RR APPLY MOTOR LO OUT
G	BRN	2008	.80	RR APPLY MOTOR HI OUT
H	RED	1988	.80	RR PARK MOTOR HI OUT

Location: Passenger Compartment, Under Left Side of I/P

BRAKE TORQUE CONTROLLER MODULE (BTCM) – J3



BLACK
12129088

PSMELC66037AA

BRAKE TORQUE CONTROLLER MODULE – J3 – 12129088				
CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
A	RED	2033	3.0	REAR BRAKE B+
B	PPL	1282	3.0	RF MOTOR HI OUT
C	BLK	1280	3.0	LF MOTOR HI OUT
D	BLK	450F	3.0	GROUND
E	BLK	450FF	3.0	GROUND
F	PNK	1281	3.0	LF MOTOR LO OUT
G	BLK	1283	3.0	RF MOTOR LO OUT
H	RED	1633B	3.0	FRONT BRAKE B+

Location: Passenger Compartment, Under Left Side of I/P

PCM HAS DETECTED A RAM FAILURE

DTC PARAMETERS

The DTC will set any time the propulsion control module (PCM) detects a random access memory (RAM) failure.

ACTION TAKEN BY THE PCM

The DTC will be stored and the PCM resets. A hard RAM failure will cause the PCM to continuously reset, which will cause the SERVICE SOON telltale to flash rapidly and a loss of propulsion.

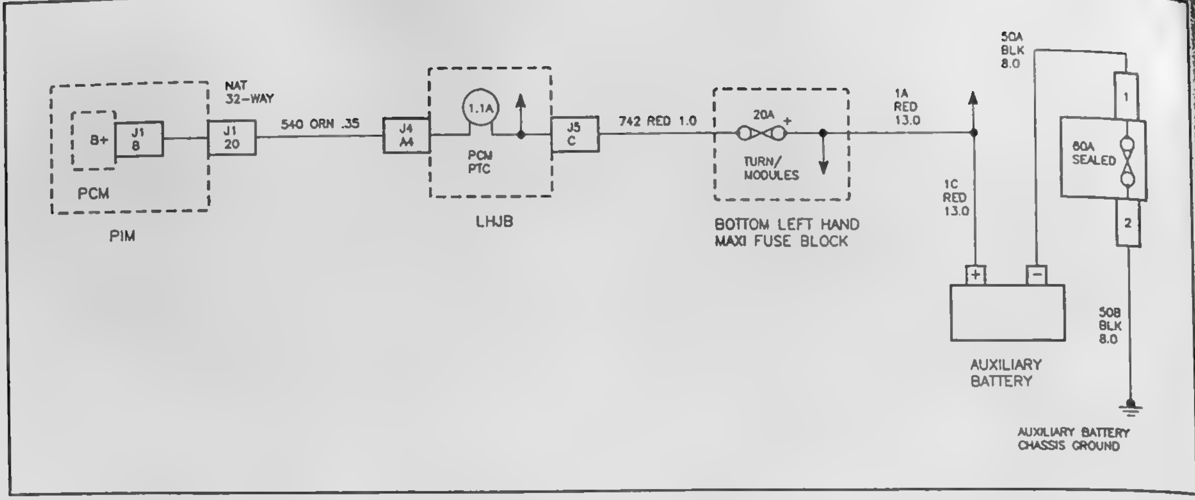
PCM will assume normal operation and propulsion will operate if failure goes away.

RELATED DTCS

None

TELLTALE ILLUMINATED:

SERVICE SOON



PSMELC67669AA

IMPROPER PROCESSOR RESET OCCURRED

The propulsion control module (PCM) can distinguish the normal powerup condition from an improper reset during operation.

DTC PARAMETERS

The DTC will set when the PCM was unable to do a proper shutdown during the last ignition cycle.

ACTION TAKEN BY PCM

When the PCM is powered up this DTC is stored. The telltale will be illuminated and then go off when the processor is reset. It will continually flash if the problem is not corrected by resetting the PCM. If telltale is flashing, propulsion is disabled.

RELATED DTCS

None

TELLTALE ILLUMINATED:

None

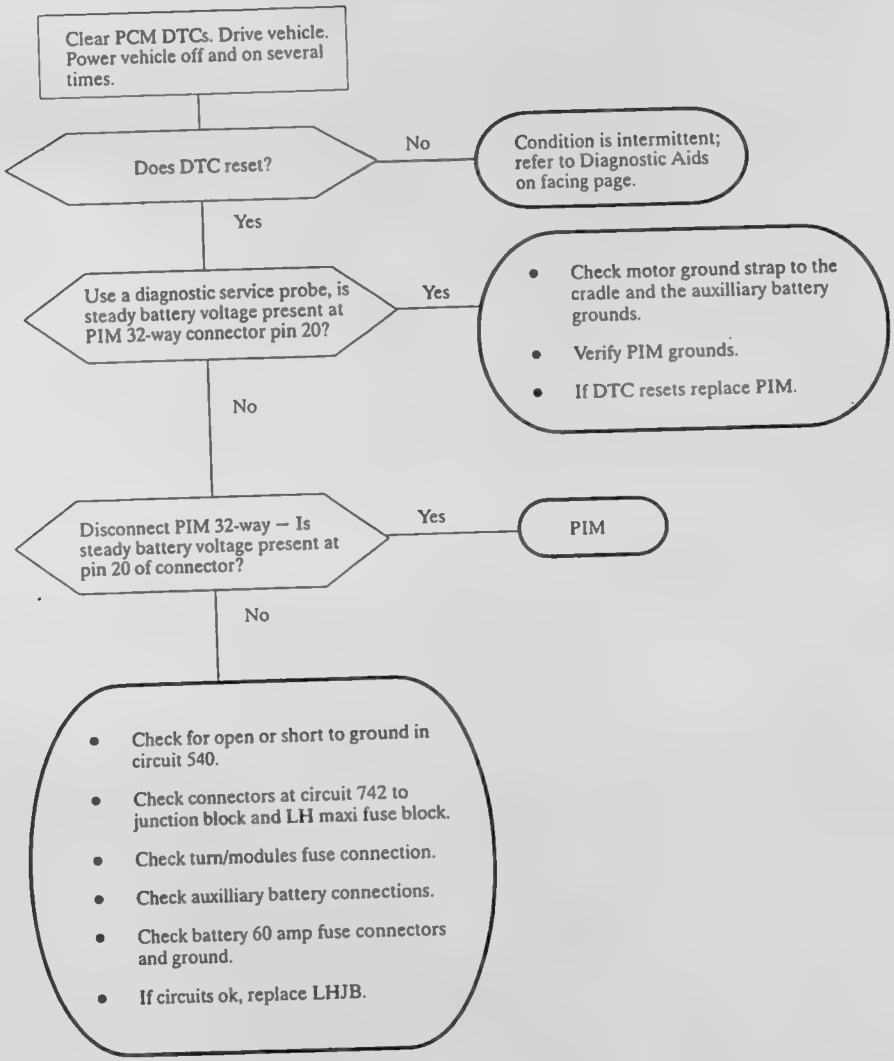
DIAGNOSTIC AIDS

- This could be caused by a problem with the PCM or noise or low voltage on the 12 volt battery supply to the PCM.
- Perform a test of the Auxilliary battery capacity.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness and auxilliary battery connectors while viewing the scan tool and see if the value changes or the DTC sets.

DTC 075
IMPROPER PROCESSOR RESET OCCURRED



The drive motor is a high efficiency AC induction motor coupled to a gear reduction unit. The gear reduction unit is connected to a differential and provides torque to the front vehicle drive shafts. The motor speed and direction is sensed by a shaft speed/direction sensor and this information is sent to the drive motor power inverter module (PIM). An external oil pump is used to lubricate the gears and bearings of the drive motor assembly. An oil pressure switch is used to monitor the pressure of the oil during vehicle operation. This information is also sent to the PIM. The AC motor is liquid cooled by the cooling system and the temperature is monitored by a temperature sensor in the cooling passage on the drive motor. Motor stator temperature is also monitored by a temperature sensor which is laminated into the windings of the motor stator. This information is used by the PIM for control and fault detection. The drive motor assembly contains a park/neutral switch (PRND). PRND information is sent to the PIM and decoded for driver information and fault detection.

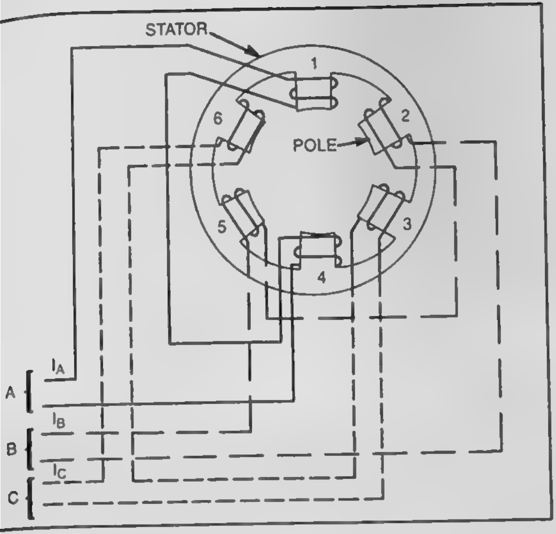
Drive Motor Functions:

- Provide power to the half shafts
- Provide regenerative braking for charging the batteries.
- Provide motor speed and direction to the PIM
- Provide mounting of the power electronics bay (PEB)
- Provide waste heat to the heat exchanger
- Lock output axle shaft during park conditions
- Provide PRND position information to the PIM

AC MOTOR THEORY OF OPERATION

The induction motor consists of a frame, stationary stator and rotor. The rotor's motion is produced by the interaction of the magnetic fields between the stator and rotor. This is based on the fundamentals of magnetism which states that; like magnetic poles repel and unlike magnetic poles attract. The magnetic field actually pulls the rotor around inside the stator.

Figure 1 shows schematically how the wires are wound around each pole of the stator. Each of the three phases is wired around an equal number of poles and each phase receives an independant current denoted by I_A, I_B, and I_C. Figure 2 shows the 3−phase 60 cycle AC current provided to the stator. Each phase current is offset by 120 degrees and maintains a relationship with the other phases. Figure 2 represents one cycle or period.



GURE 1

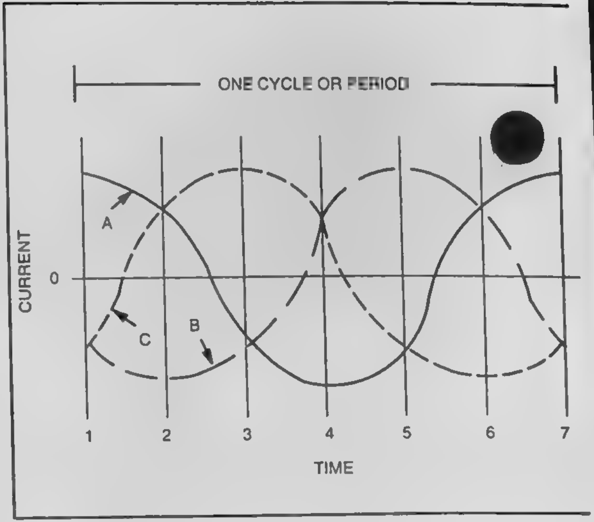


FIGURE 2

The drive motor has a peak torque rating 141 N•m (104 ft–lb) at 7000 RPM. The peak power rating is 103 kw (138 Hp) at 7000 RPM. The efficiency of the motor is as follows:

48 km/h (30 MPH)	90%
89 km/h (55 MPH)	91%
105 km/h (65 MPH)	91%

DRIVE MOTOR SLIP

The PIM calculates the drive motor slip commands based upon requested torque, battery voltage, drive motor shaft rate and direction, PRND mode, drive motor temperature and drive or braking status.

DRIVE MOTOR CONTROL

The drive motor is controlled by three phase AC voltage from the PIM. The PIM inverts the high voltage DC bus (supplied from battery pack) into three high frequency square waves which becomes 3–phase AC power to drive the motor. The drive motor converts this three phase AC into mechanical power through the induction motor. The signals to the drive motor are calculated from the current command and the slip commands.

During regen mode the drive motor sends AC voltage back to the PIM which is converted into DC and returned to the battery pack for storage.

DRIVE MOTOR PERFORMANCE LIMITING

The PIM will limit torque current and turn On the reduced performance telltale whenever one of the following conditions is active:

- PIM over–temperature
- Drive motor stator over–temperature
- Accelerator Pedal failure
- Low battery pack voltage
- Park/Neutral direction is not equal to speed/direction sensor direction
- Loss of oil pressure

The PIM will also decrease the torque current to provide improved brake performance and to limit drive motor shaft speed.

The PIM will not provide torque to the drive motor under the following conditions:

- Park/Neutral switch (PRND) is in PARK or NEUTRAL
- High voltage interlock fault
- Internal PIM critical fault

VEHICLE SPEED LIMITING

The PIM will limit vehicle speed in the forward direction to 129 km/h (80 mph) and in the reverse direction to 48 km/h (30 mph).

COAST DOWN FUNCTION

When the accelerator pedal is released the PIM will decrease the torque current as a function of drive motor shaft speed/direction torque. This simulates an auto transaxle on an internal combustion vehicle at idle, in drive or reverse.

Coast down increases regen when coasting or braking and can extend vehicle range under certain stop and go driving conditions.

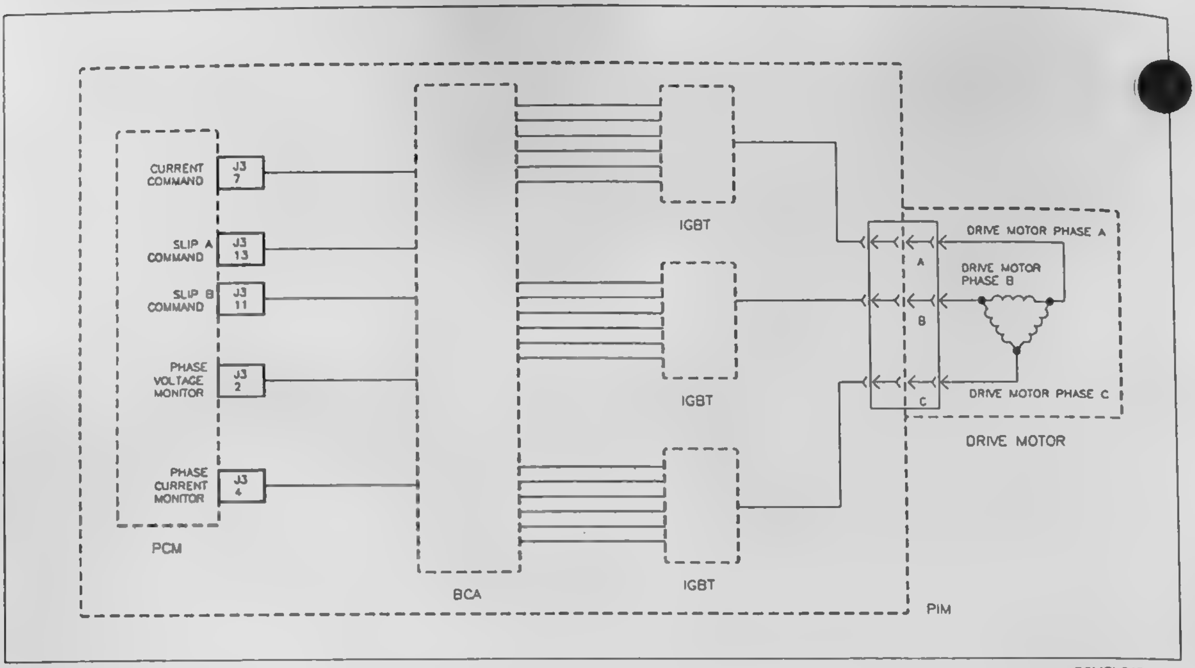
CREEP FUNCTION

When the vehicle is stopped and the accelerator pedal position input indicates its minimum position, the PIM will provide a positive torque current to the drive motor. This provides a slight creep forward or backward when the brake is released and resembles an automatic transaxle on an internal combustion engine vehicle at idle, in drive or reverse.

DRIVE MOTOR FINAL DRIVE GEARS

The final drive assembly is a direct drive assembly with a 10.95:1 gear ratio. When the drive motor is spinning in the clockwise direction the gear train is propelling the shafts in the forward direction. When shifted to reverse the motor torque direction is, counter clockwise, causing the drive shafts to rotate in the reverse direction.

DTC 087 – BCA SLIP DIAGNOSTIC FAULT



PSMELC67655AD

BCA SLIP DIAGNOSTIC FAULT

The propulsion control module (PCM) sends slip frequency and direction to the bias control assembly (BCA). It is passed by two signals slip A and slip B. When the slip A signal is leading the slip B signal this indicates the drive motor direction as forward. If slip A lags slip B this indicates the drive motor direction as reverse. The PCM slip frequency is multiplied by 128 and used for the desired drive motor slip.

DTC PARAMETERS

This DTC will set anytime the BCA has indicated this fault is the fault register.

ACTION TAKEN BY THE PCM

This DTC is set and propulsion is disabled

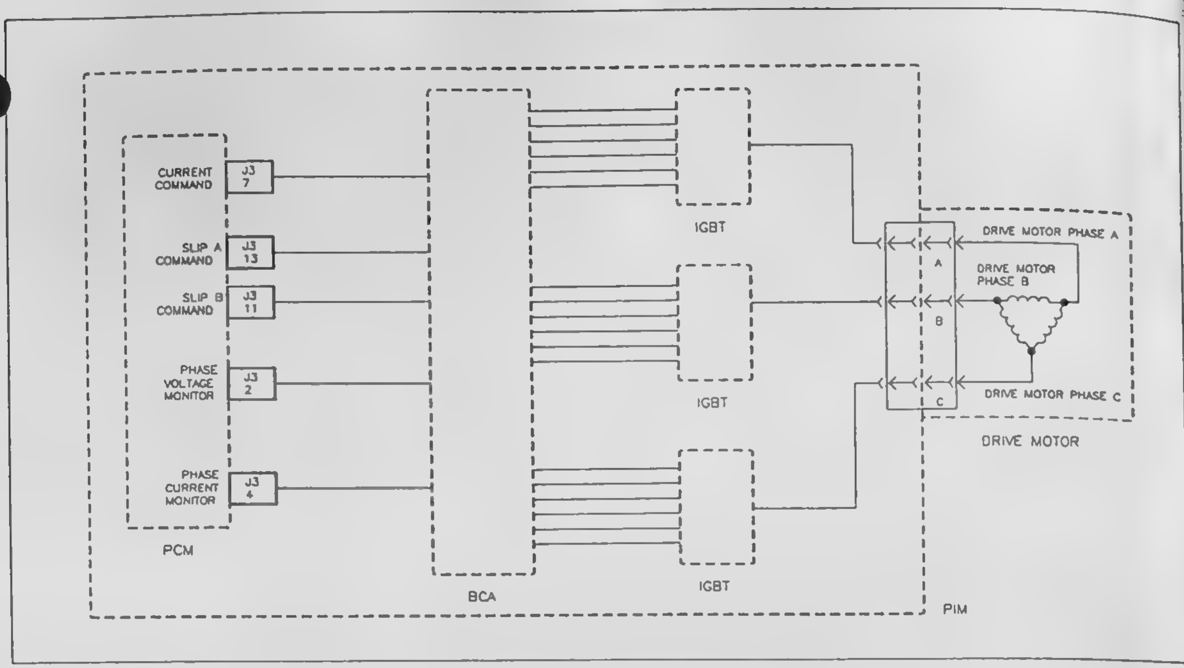
RELATED DTCS

PCM 44

TELLTALE ILLUMINATED:

None

DTC 088 – BCA CURRENT COMMAND FAULT



PSMELC6765SAD

BCA CURRENT COMMAND FAULT

The propulsion control module (PCM) receives inputs to calculate the required current command. The current command is sent to the bias control assembly (BCA) as a pulse width modulated (PWM) signal and this signal is used for drive motor operation. The PCM receives a feedback of the signal to ensure the proper signal was received.

DTC PARAMETERS

This DTC will set anytime the BCA has indicated this fault in the fault register.

ACTION TAKEN BY THE PCM

This DTC is set and propulsion is disabled.

RELATED DTCS

PCM 44

TELLTALE ILLUMINATED:

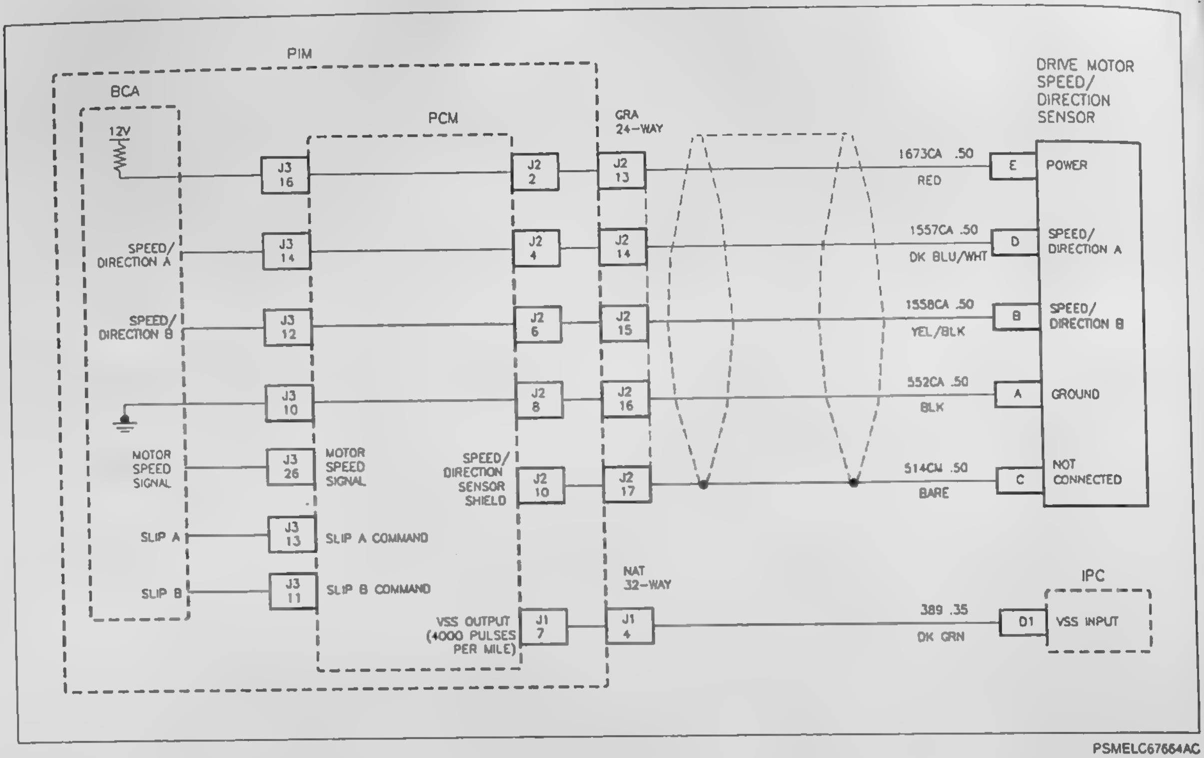
None

DTC 088
BCA CURRENT COMMAND FAULT

If DTC 88 is set it is due to an internal PCM or BCA board fault.

Replace drive motor power inverter module (PIM).

DTC 089 – BCA FAILED FORWARD SLIP DIRECTION TEST AT POWERUP



PSMELC67664AC

BCA FAILED FORWARD SLIP DIRECTION TEST AT POWERUP

The propulsion control module (PCM) sends slip frequency and direction to the bias control assembly (BCA). It is passed by two signals—slip A and slip B. When the slip A signal is leading the slip B signal, this indicates the drive motor direction as forward. If slip A lags, slip B this indicates the drive motor direction as reverse. The PCM slip frequency is multiplied by 128 and used for the desired drive motor slip.

DTC PARAMETERS

This DTC will set anytime the BCA detects an invalid response to PCM commanded forward slip signal at power-up.

ACTION TAKEN BY THE PCM

This DTC is set and propulsion is disabled.

RELATED DTCS

None

TELLTALE ILLUMINATED:

Service Now

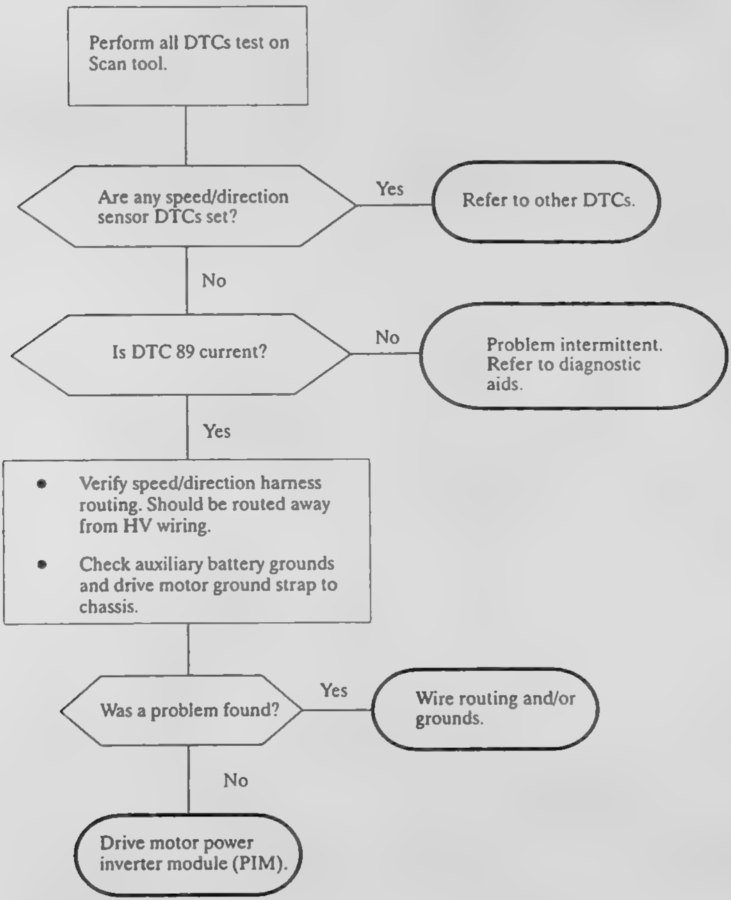
DIAGNOSTIC AIDS

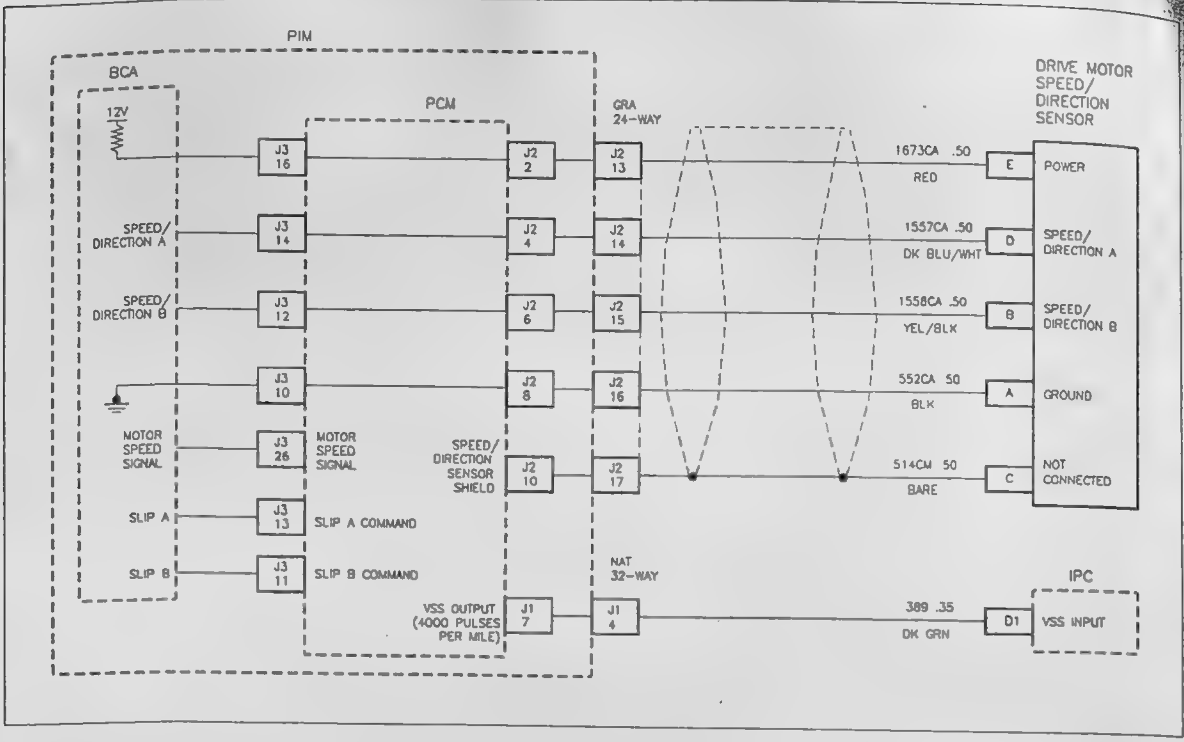
- The PCM expects to see zero volts at power up on the speed/direction sensor.
- A noisy speed/direction sensor signal can cause this DTC to set. Verify routing of harness and vehicle grounds.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

DTC 089
BCA FAILED FORWARD SLIP DIRECTION TEST AT POWER-UP





PSMELC67664AC

BCA FAILED REVERSE SLIP DIRECTION AT POWERUP

The propulsion control module (PCM) sends slip frequency and direction to the bias control assembly (BCA). It is passed by two signals—slip A and slip B. When the slip A signal is leading the slip B signal, this indicates the drive motor direction as forward. If slip A lags, slip B this indicates the drive motor direction as reverse. The PCM slip frequency is multiplied by 128 and used for the desired drive motor slip.

DTC PARAMETERS

This DTC will set anytime the BCA detects an invalid response to PCM commanded reverse slip direction signal at power-up.

ACTION TAKEN BY THE PCM

This DTC is set and propulsion is disabled.

RELATED DTCS

None

TELLTALE ILLUMINATED:

Service Now

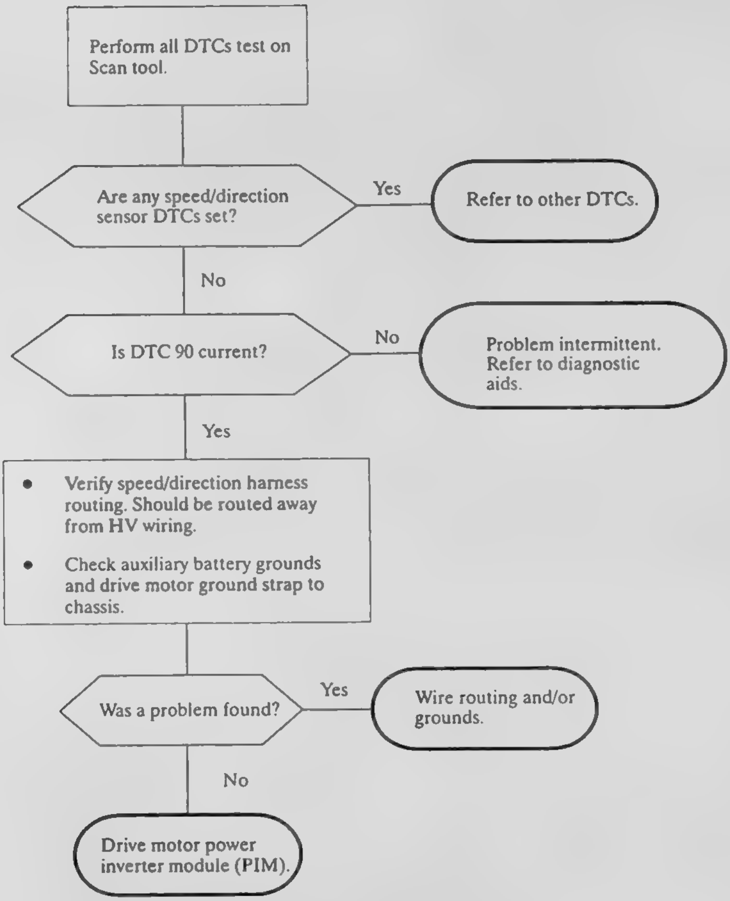
DIAGNOSTIC AIDS

- The PCM expects to see zero volts at power up on the speed/direction sensor.
- A noisy speed/direction sensor signal can cause this DTC to set. Verify routing of harness and vehicle grounds.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

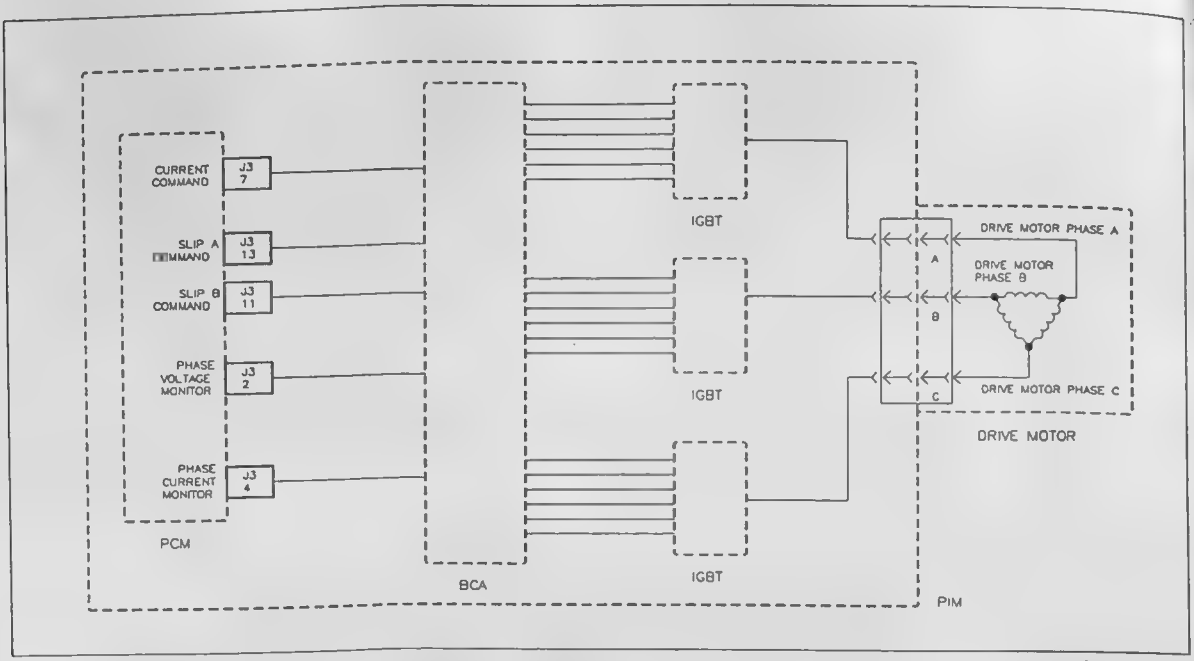
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the scan tool and see if the value changes or the DTC sets.

DTC 090
BCA FAILED REVERSE SLIP DIRECTION AT POWERUP



DTC 111 – BCA PHASE VOLTAGE HAS EXCEEDED INVALID PHASE VOLTAGE THRESHOLD



PSMELC67655AD

BCA PHASE VOLTAGE HAS EXCEEDED INVALID PHASE VOLTAGE THRESHOLD

Any time vehicle speed is below 10 mph and no DTCs set the propulsion control module (PCM) will run a voltage test. PCM will look for phase voltage feedback signal to be less than 25 percent of maximum voltage.

DTC PARAMETERS

This DTC will set anytime the vehicle speed is less than 16 km/h (10 mph) and phase voltage is greater than 25 percent of maximum voltage.

ACTION TAKEN BY THE PCM

This DTC is set, the Service Now telltale is illuminated, and propulsion is disabled.

RELATED DTCS

None

TELLTALE ILLUMINATED:

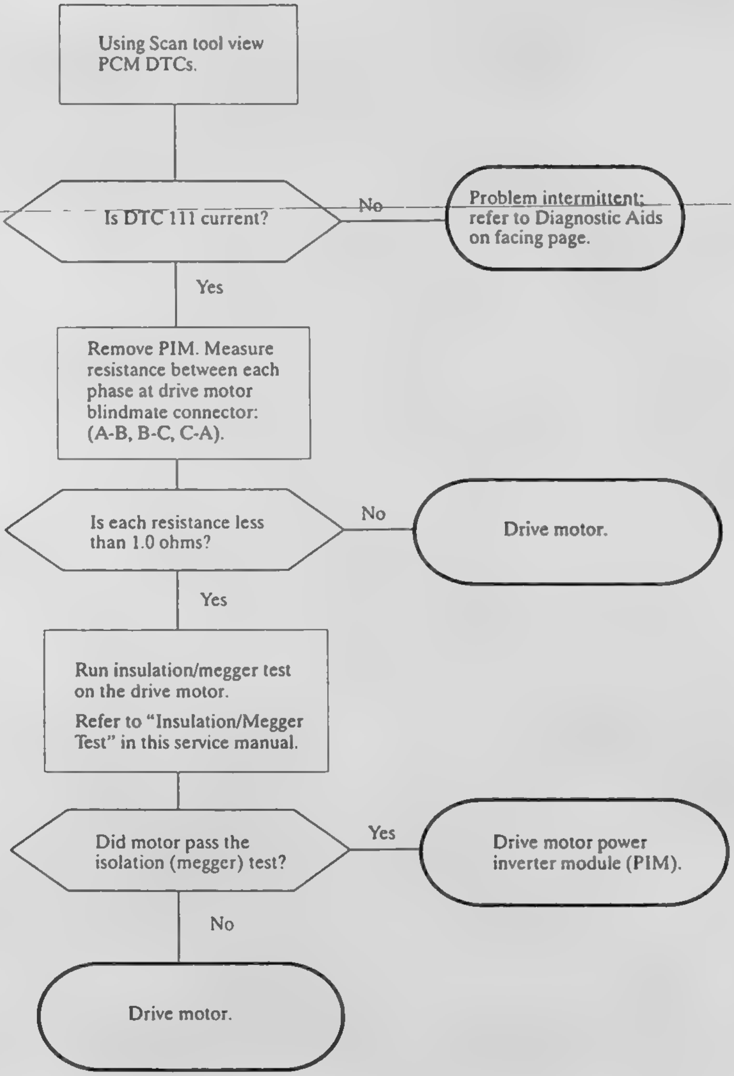
SERVICE NOW

DIAGNOSTIC AIDS

- This DTC may be caused by an open in one of the drive motor phases.
- Run at low speed = 2500 rpm for 500 ms. Look for phase voltage to be less than 25 percent of max voltage.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 111
BCA PHASE VOLTAGE HAS EXCEEDED INVALID PHASE VOLTAGE THRESHOLD



DTC 112 – QUAD DRIVER 1 OUTPUT FAULT

A quad driver module (QDM) is an electronic switch that completes a ground circuit when switched On. The QDM independently controls four separate outputs. A load is connected between battery voltage and the QDM allowing the driver to control the output. Each QDM has fault detection logic that compares driver input and output voltages. The logic expects to measure less than 3.0 volts when the driver is On and greater than 7.0 volts when Off. Each QDM has only one fault line that will detect a fault on any of the four outputs.

DTC PARAMETERS

This DTC will set anytime there is an open, short to ground or short to voltage on any of the QDM output circuits for 0.25 seconds.

– PSA enable command circuit

– Current command to BCA circuit

– Slip A to BCA circuit

– Slip B to BCA circuit

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale is illuminated, this DTC is set.

RELATED DTCS

None

TELLTALE ILLUMINATED:

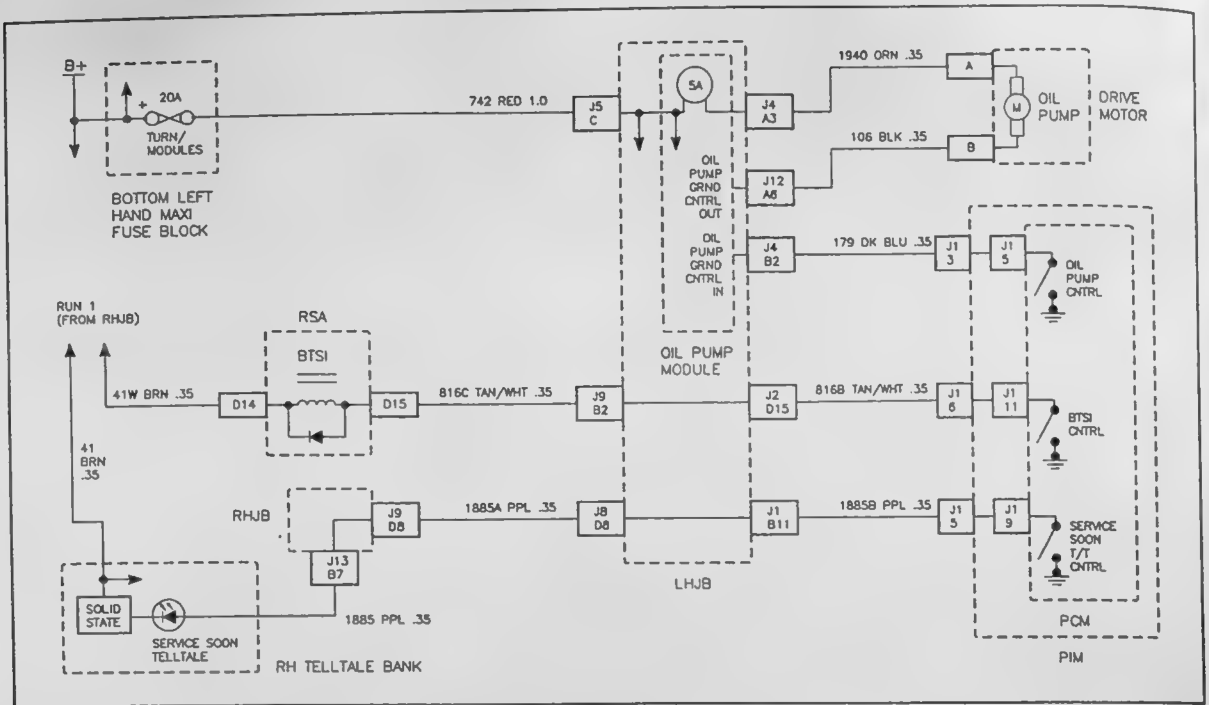
SERVICE SOON

DTC 112
QUAD DRIVER 1 OUTPUT FAULT

If DTC 112 is set it is due to an internal PCM fault.

Replace drive motor power inverter module (PIM).

DTC 113 – QUAD DRIVER 2 OUTPUT FAULT



PSMELC67670AA

QUAD DRIVER 2 OUTPUT FAULT

A quad driver module (QDM) is an electronic switch which completes a ground circuit when switched On. The QDM independently controls four separate outputs. A load is connected between battery voltage and the QDM allowing the driver to control the output. Each QDM has fault detection logic which compares driver input and output voltages. The logic expects to measure less than 3.0 volts when the driver is On and greater than 7.0 volts when Off. Each QDM has only one fault line that will detect a fault on any of the four outputs.

DTC PARAMETERS

This DTC will set anytime there is an open, short to ground or short to voltage on any of the QDM output circuits for 0.25 seconds.

– SERVICE SOON telltale circuit

– Oil pump circuit (vehicle will be in reduced performance if this fails)

– BTSI circuit (vehicle cannot be shifted out of park if this fails)

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale is illuminated and this DTC is set.

RELATED DTCS

None

TELLTALE ILLUMINATED:

SERVICE SOON

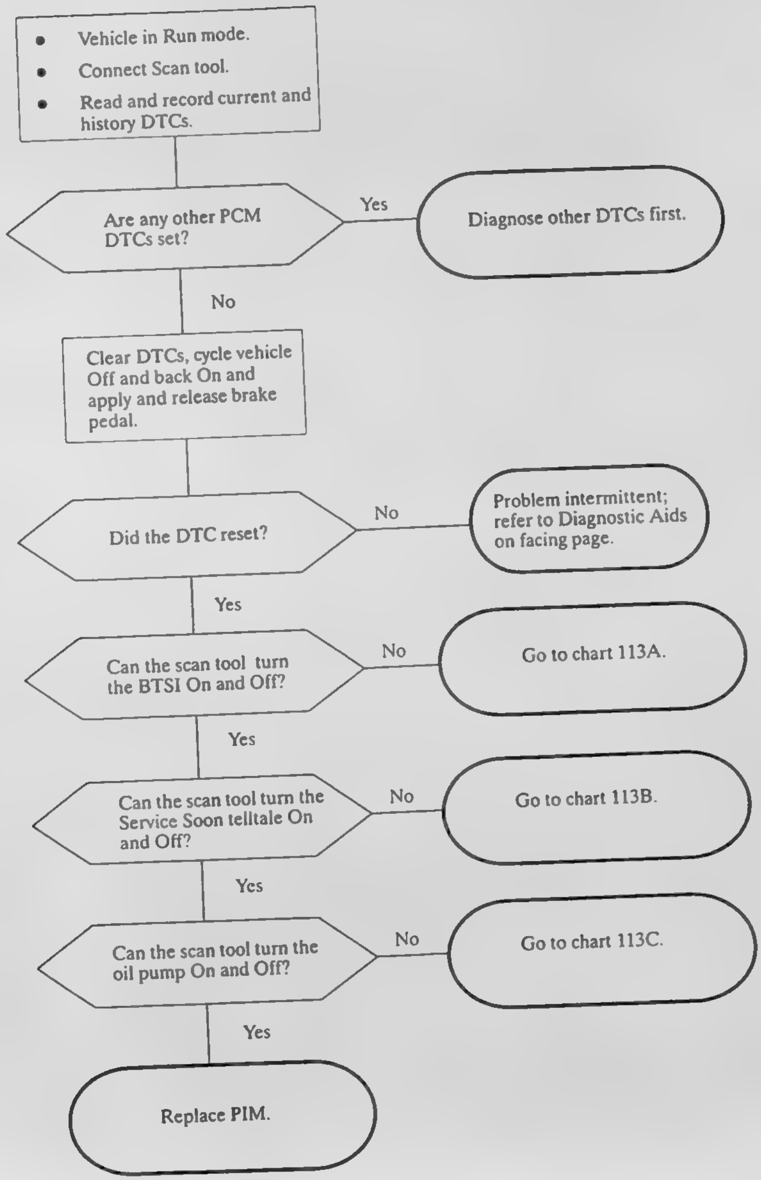
DIAGNOSTIC AIDS

- Command ON = QDM should see low.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

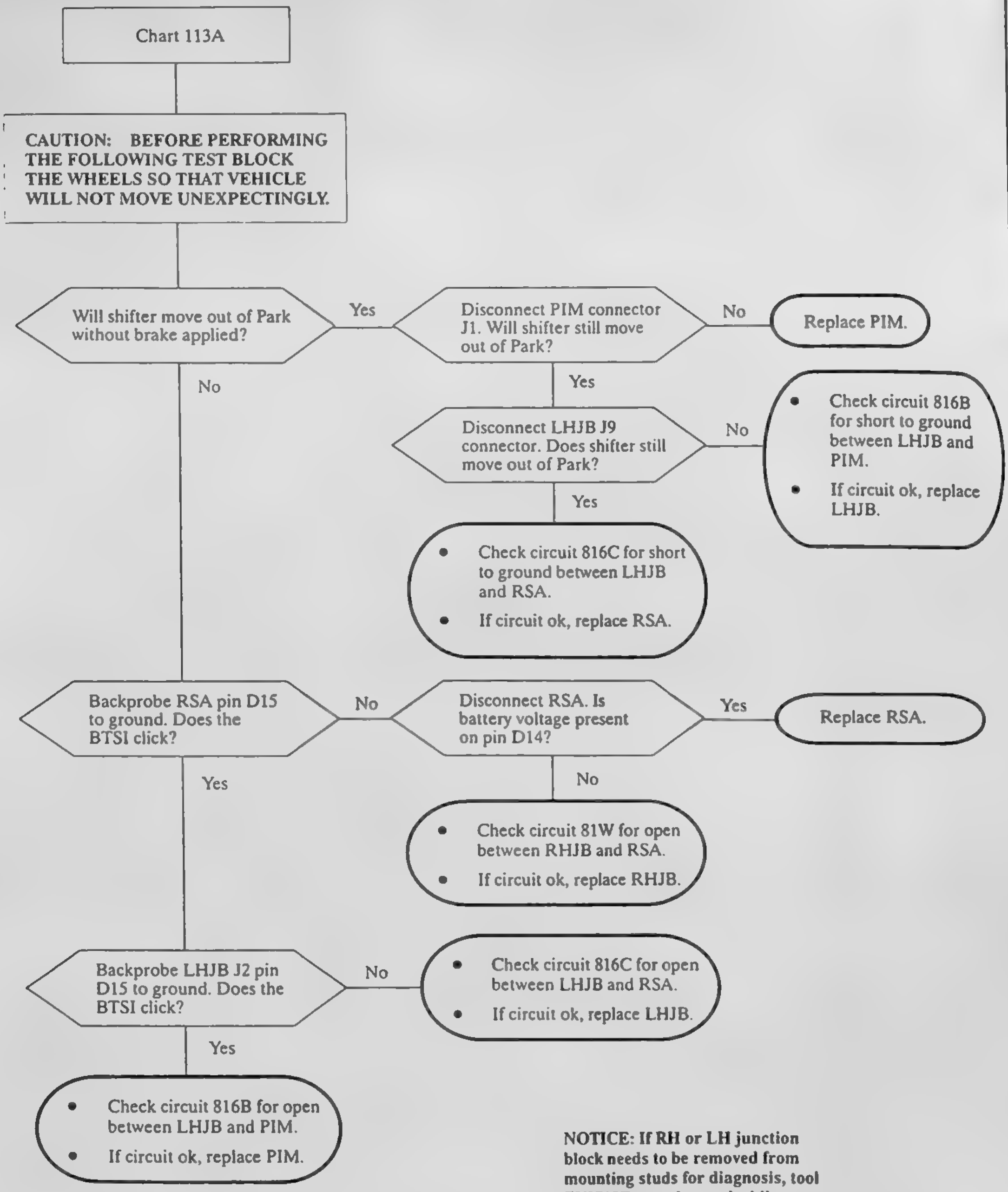
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

DTC 113
QUAD DRIVER 2 OUTPUT FAULT (PAGE 1 OF 4)

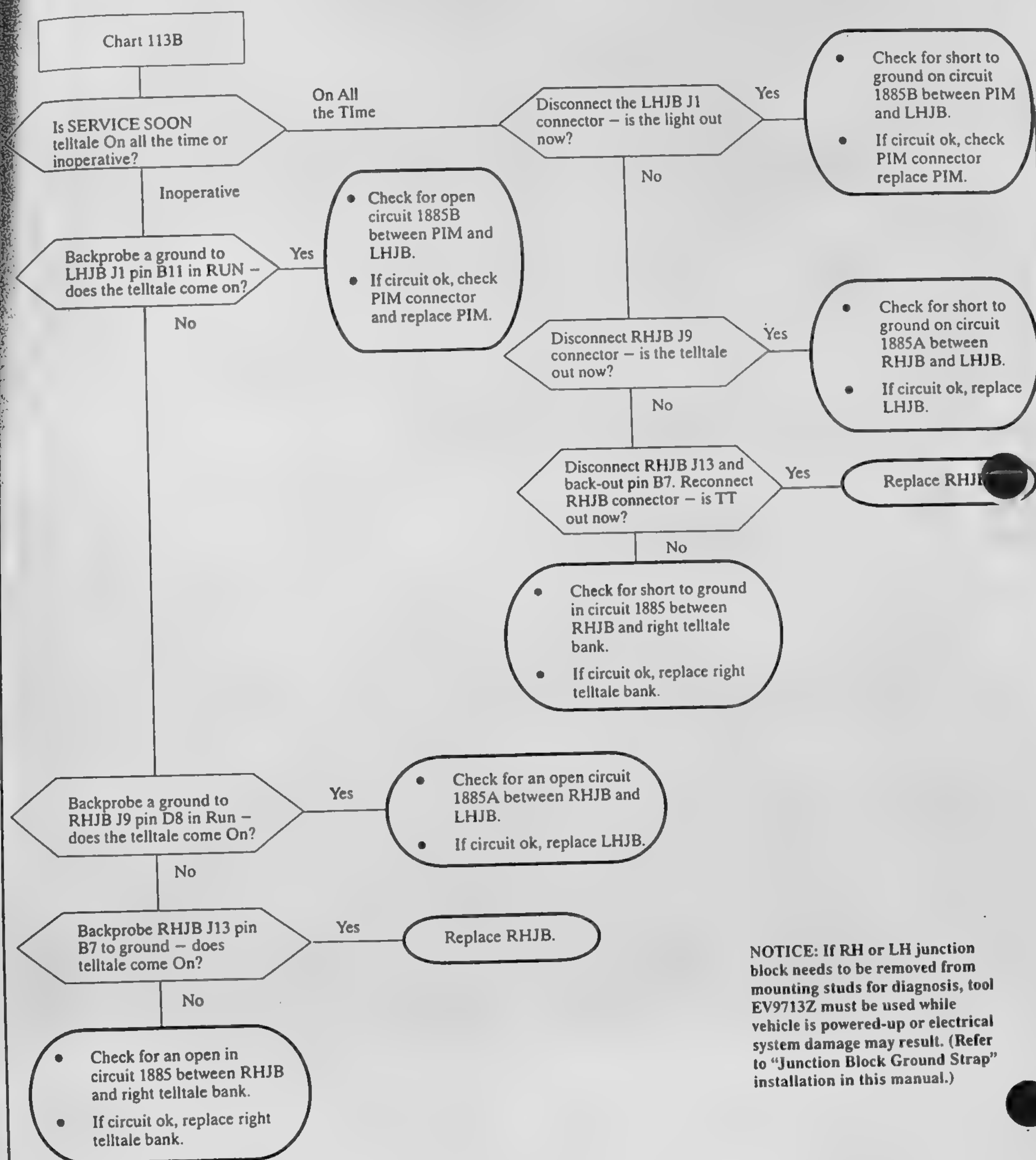


DTC 113A
QUAD DRIVER 2 OUTPUT FAULT (PAGE 2 OF 4)



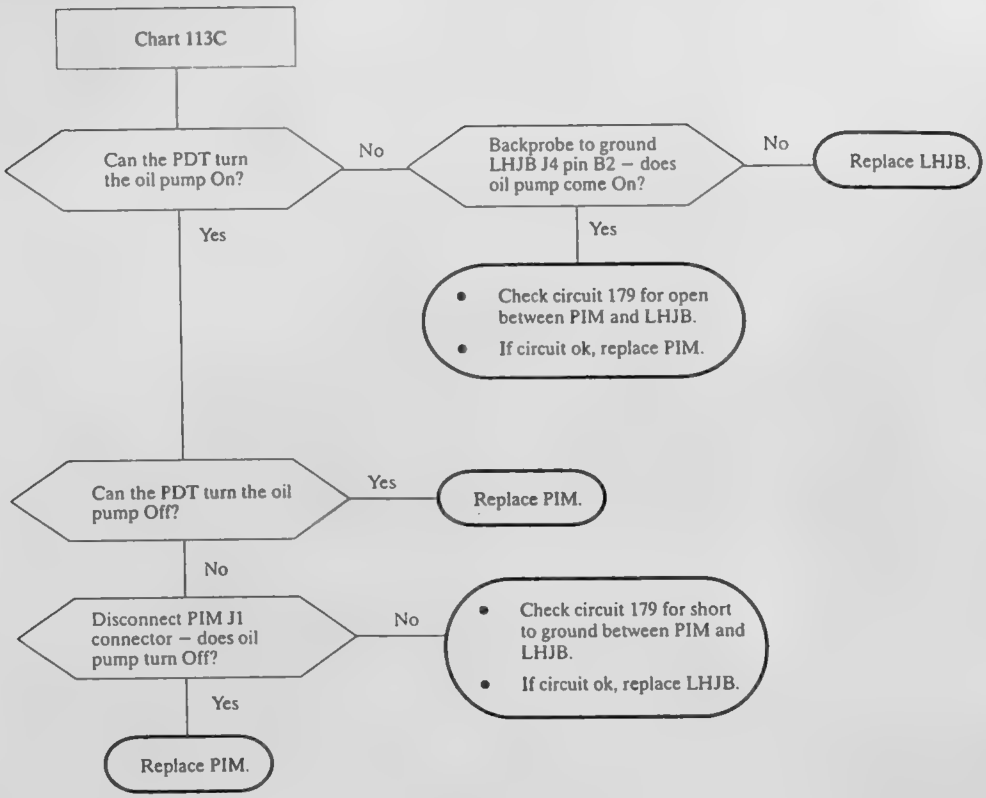
NOTICE: If RH or LH junction block needs to be removed from mounting studs for diagnosis, tool EV9713Z must be used while vehicle is powered-up or electrical system damage may result. (Refer to "Junction Block Ground Strap" installation in this manual.)

DTC 113B
QUAD DRIVER 2 OUTPUT FAULT (PAGE 3 OF 4)

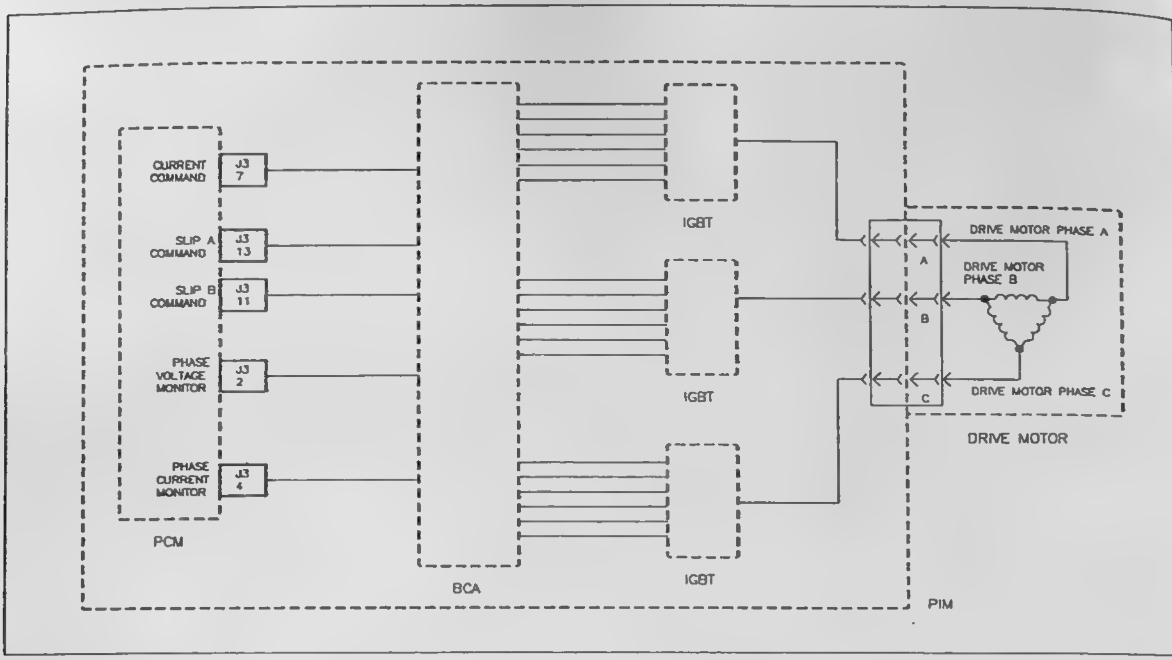


NOTICE: If RH or LH junction block needs to be removed from mounting studs for diagnosis, tool EV9713Z must be used while vehicle is powered-up or electrical system damage may result. (Refer to "Junction Block Ground Strap" installation in this manual.)

DTC 113C
QUAD DRIVER 2 OUTPUT FAULT (PAGE 4 OF 4)



DTC 115 – CURRENT FEEDBACK SIGNAL GREATER THAN COMMANDED DURING REGEN



PSMELC67655AD

CURRENT FEEDBACK SIGNAL GREATER THAN COMMANDED DURING REGEN

The propulsion control module (PCM) will command regeneration to provide current for recharging the batteries. It will monitor the drive motor phase current going into the battery pack to verify the battery pack is receiving the requested amount of current.

DTC PARAMETERS

This DTC will set any time the actual current is above 15 percent of the commanded current during regen.

ACTION TAKEN BY THE PCM

the SERVICE SOON telltale is illuminated, this DTC will be set and regen is disabled.

RELATED DTCS

PCM 116, 117, 118, 119

TELLTALE ILLUMINATED:

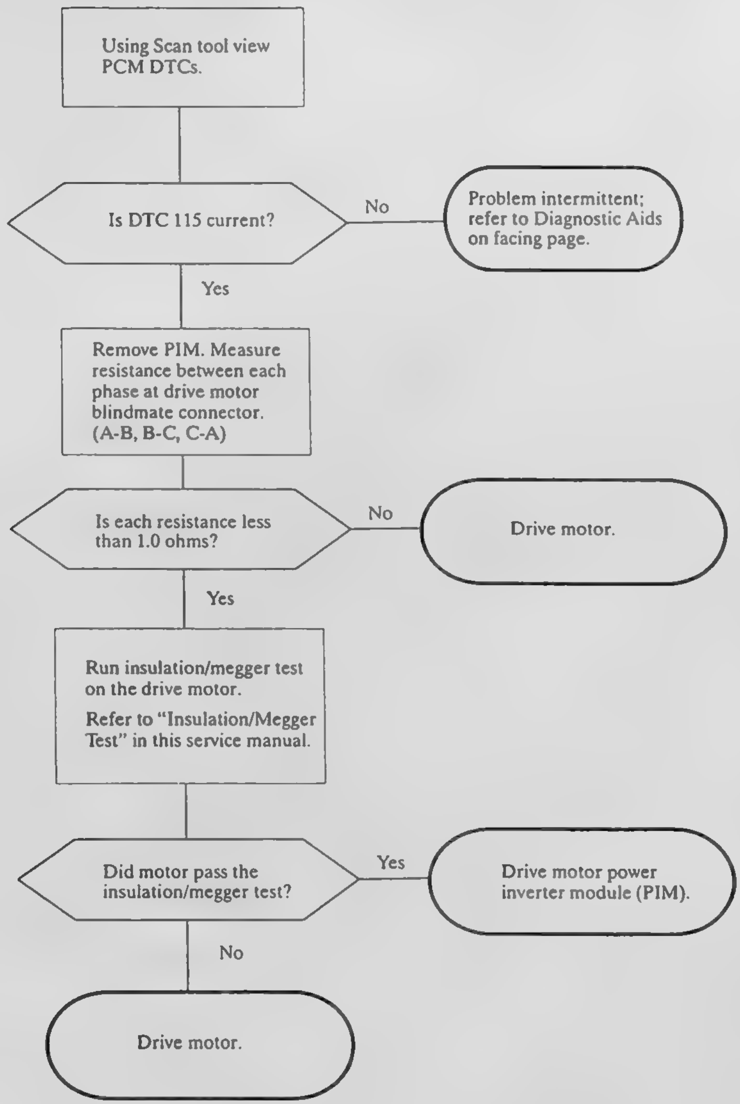
SERVICE SOON

DIAGNOSTIC AIDS

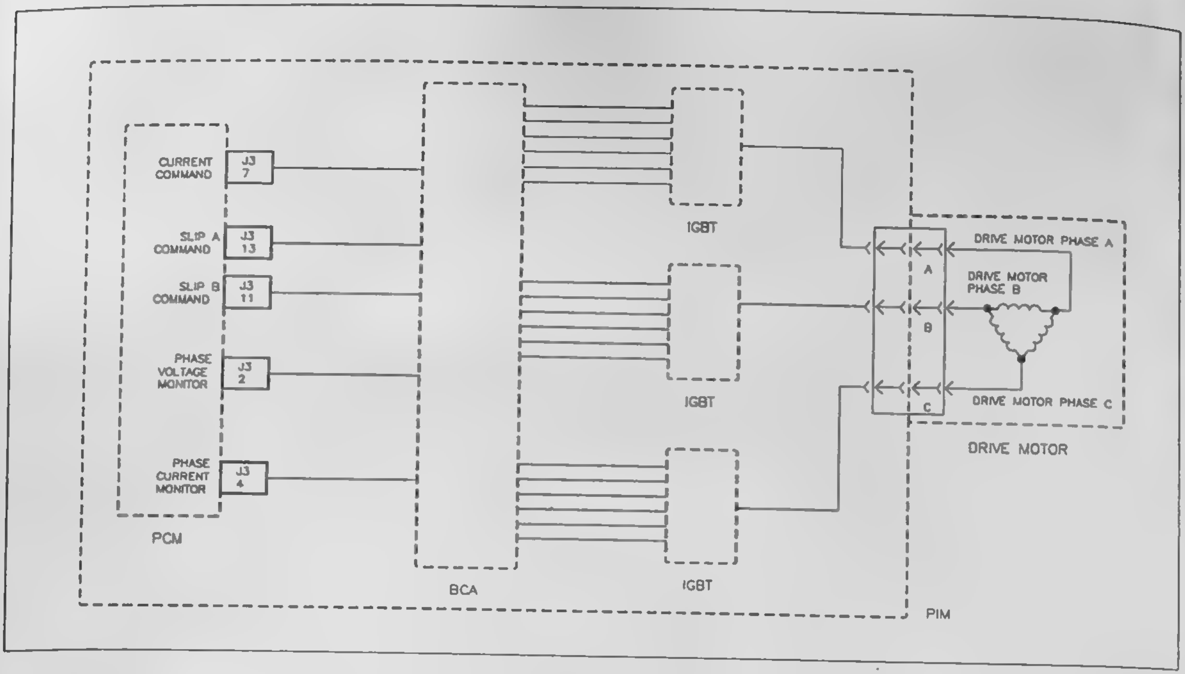
- This DTC may be caused by an open in one of the drive motor phases.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 115
CURRENT FEEDBACK SIGNAL GREATER THAN COMMANDED DURING REGEN



DTC 116 – CURRENT FEEDBACK SIGNAL GREATER THAN PCM COMMANDED CURRENT DURING PROPULSION



CURRENT FEEDBACK SIGNAL GREATER THAN PCM COMMANDED CURRENT DURING PROPULSION

Propulsion control module (PCM) commands the required current based on the accelerator pedal input. The bias control assembly (BCA) supplies the required current and reports back to PCM amount of current sent to drive motor.

DTC PARAMETERS

This DTC will set anytime current feedback exceeds commanded by 15 percent and the shaft speed is greater than 1000 rpm

ACTION TAKEN BY THE PCM

The SERVICE NOW telltale is illuminated, this DTC is set, and propulsion is disabled.

RELATED DTCS

PCM 115, 117, 118, 119

TELLTALE ILLUMINATED:

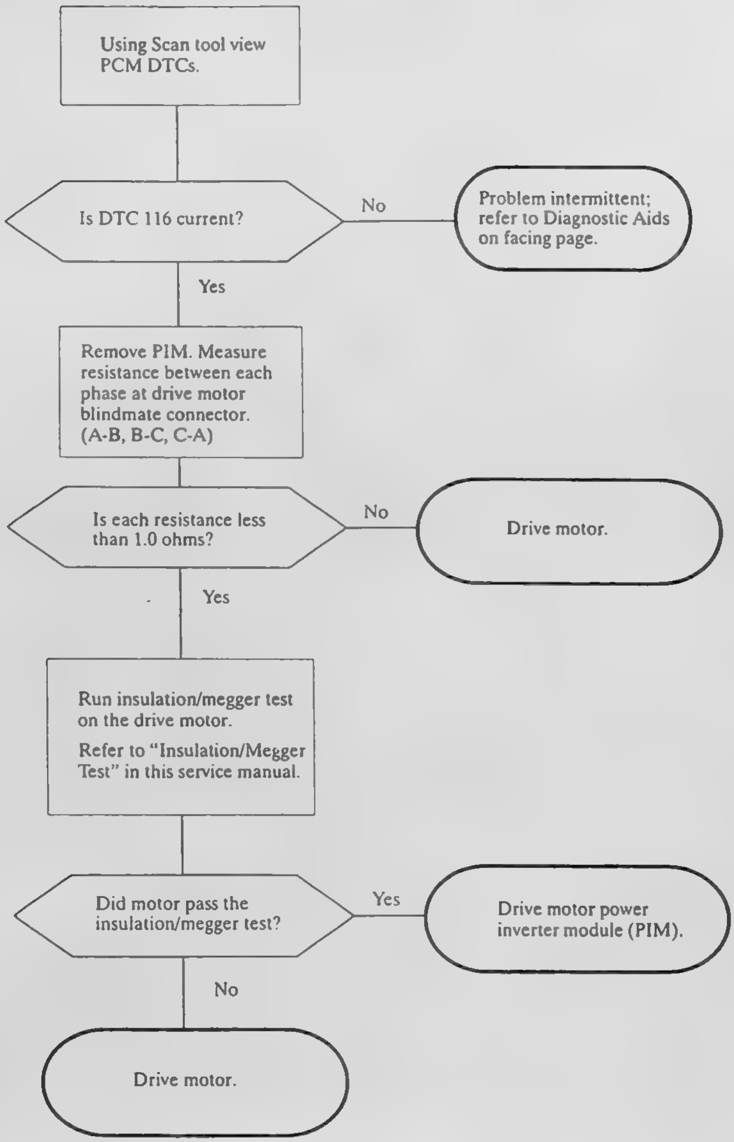
SERVICE NOW

DIAGNOSTIC AIDS

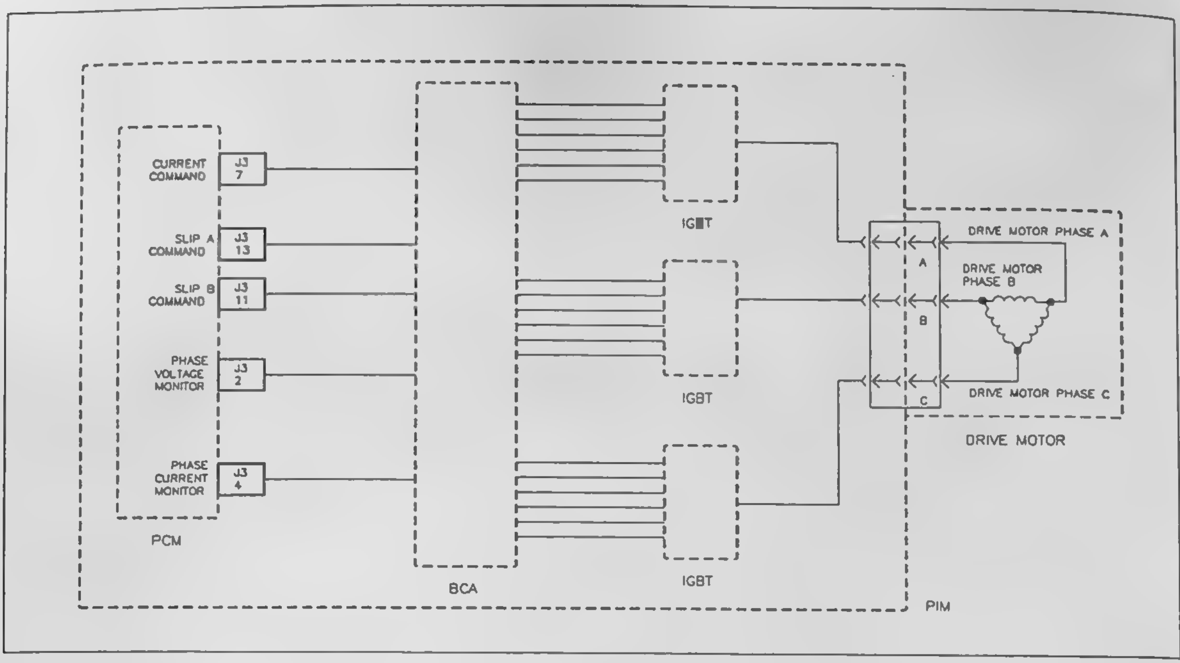
When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 116
CURRENT FEEDBACK SIGNAL GREATER THAN PCM COMMANDED CURRENT DURING PROPULSION



DTC 117 – BCA PHASE CURRENT COMMAND READS ZERO



PSMELC67655AD

BCA PHASE CURRENT COMMAND READS ZERO

Propulsion control module (PCM) commands the required current based on the accelerator pedal input. The bias control assembly (BCA) supplies the required current and reports back to PCM amount of current sent to drive motor.

DTC PARAMETERS

This DTC will set anytime the phase current feedback is less than or equal to 32 amps when propulsion is commanded and shaft speed is greater than 1,000 rpm.

ACTION TAKEN BY THE PCM

The SERVICE NOW telltale is illuminated, this DTC is set, and propulsion is disabled.

RELATED DTCS

PCM 115, 116, 118, 119

TELLTALE ILLUMINATED:

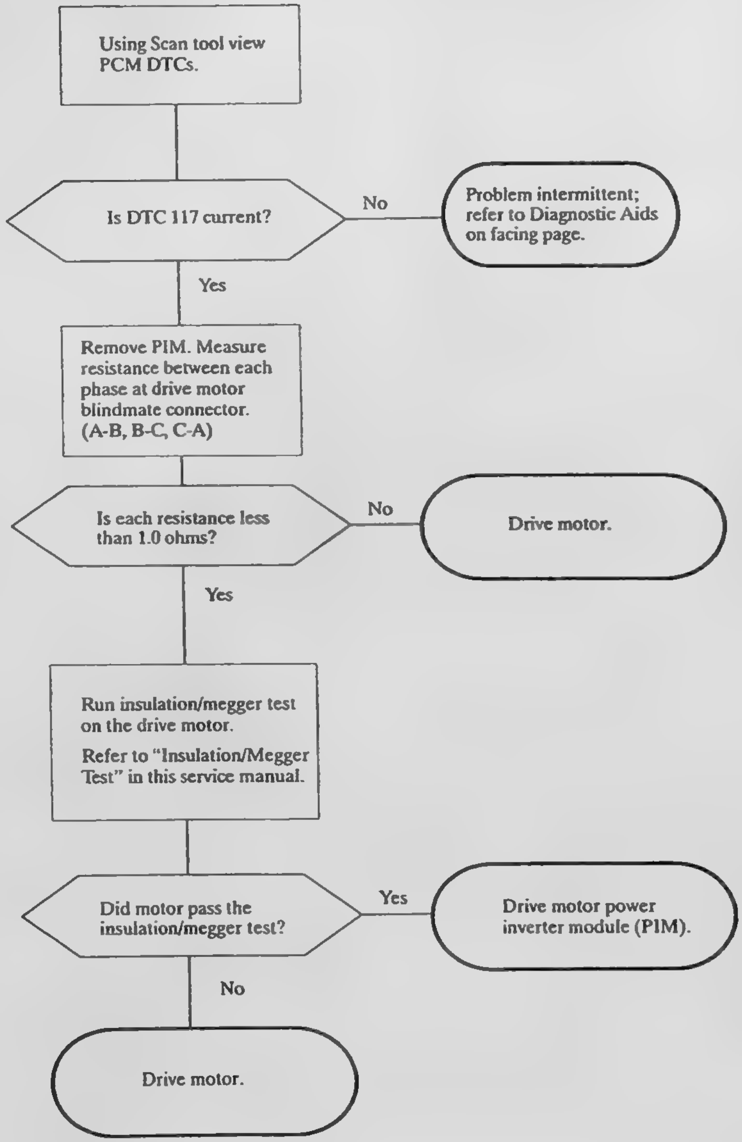
SERVICE NOW

DIAGNOSTIC AIDS

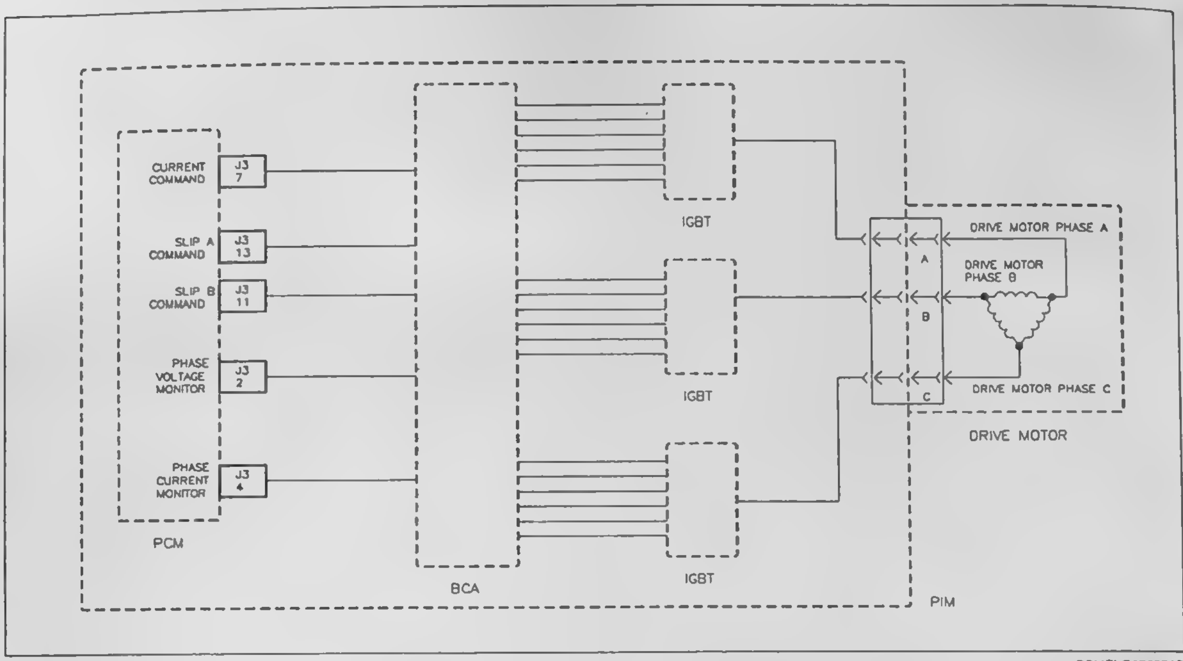
- This DTC can be caused by an open motor winding or PIM current sensor.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 117
BCA PHASE CURRENT COMMAND READS ZERO



DTC 118 – CURRENT FEEDBACK SIGNAL LESS THAN PCM COMMANDED DURING REGEN



CURRENT FEEDBACK SIGNAL LESS THAN PCM COMMANDED DURING REGEN

The propulsion control module (PCM) will command regeneration to provide current for recharging the batteries. It will monitor the drive motor phase current going into the battery pack to verify the battery pack is receiving the requested current.

DTC PARAMETERS

This DTC will set any time the commanded signal has exceeded actual current during regen when other shaft speed is greater than 1,000 rpm.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale is illuminated, this DTC is set, and propulsion is disabled.

RELATED DTCS

PCM 115, 116, 117, 119

TELLTALE ILLUMINATED:

SERVICE SOON

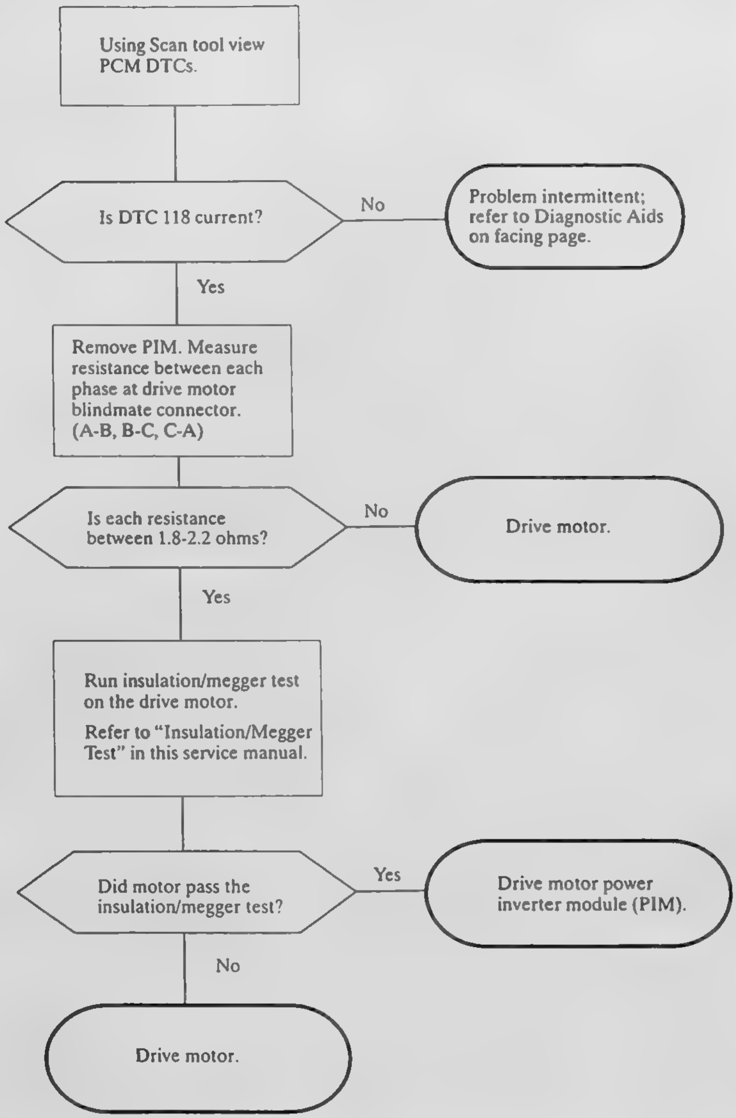
DIAGNOSTIC AIDS

- This DTC can be caused by an open motor winding or PIM current sensor.

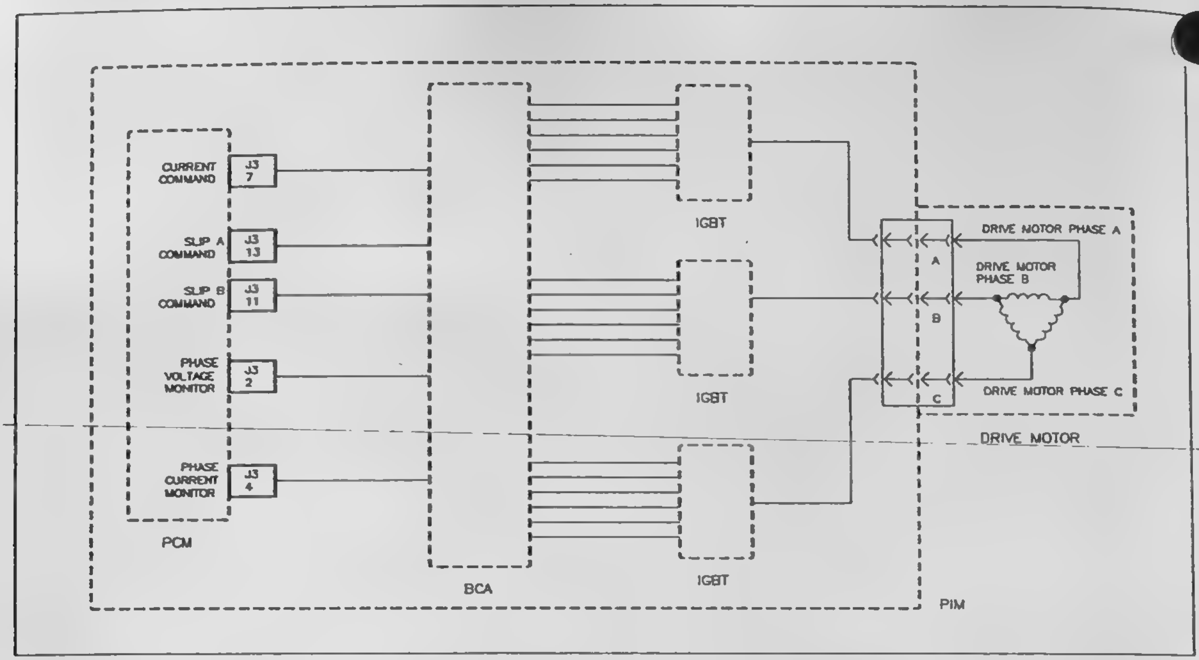
When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 118
CURRENT FEEDBACK SIGNAL LESS THAN PCM COMMANDED DURING REGEN



DTC 119 – CURRENT FEEDBACK SIGNAL IS LESS THAN PCM COMMANDED DURING PROPULSION



PSMELC67655AD

CURRENT FEEDBACK SIGNAL IS LESS THAN PCM COMMANDED DURING PROPULSION

Propulsion control module (PCM) commands the required current based on the accelerator pedal input. The bias control assembly (BCA) supplies the required current and reports back to PCM amount of current sent to drive motor.

DTC PARAMETERS

This DTC will set anytime the current is 15 percent lower than the actual command and shaft speed is greater than 1000 rpm.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC is set.

RELATED DTCS

PCM 115, 116, 117, 118

TELLTALE ILLUMINATED:

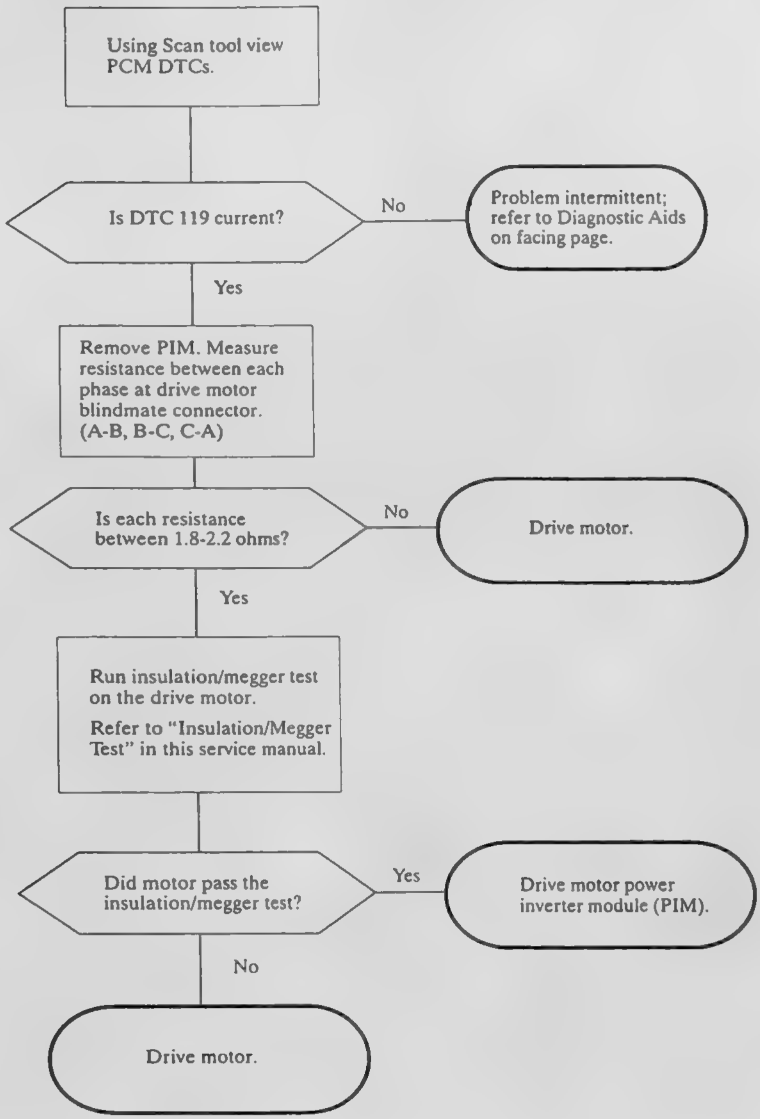
SERVICE SOON

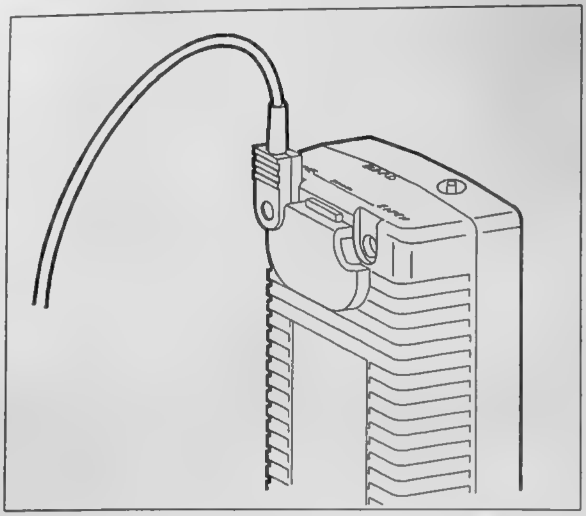
DIAGNOSTIC AIDS

- This DTC may be caused by an open in the motor windings.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 119
CURRENT FEEDBACK SIGNAL IS LESS THAN PCM COMMANDED DURING PROPULSION





PSMGCH68328AA

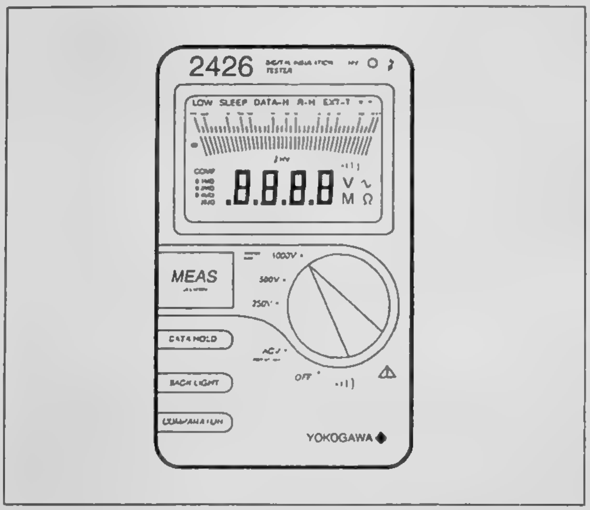
INSULATION/MEGGER TEST

REMOVAL

1. Remove the power electronics bay (PEB). (Refer to the "PEB" removal procedure in this manual.)
2. Install EV9735Z (Digital Insulation tester) test leads into the back of tester. Black wire to EARTH (ground) and Orange wire LINE to (line probe).

IMPORTANT: Make sure the leads are fully seated into tester.

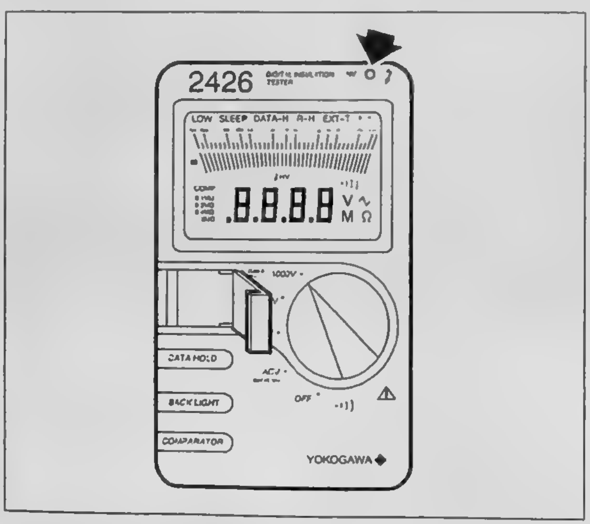
3. Connect the Earth ground (Black lead) to the chassis of the motor (motor housing).



PSMELC68361AA

4. Turn the meter switch to the 1000 volt range.
5. Make sure the orange probe (LINE) is not touching anything.

CAUTION: TO PREVENT SHOCK OR BURNS ALWAYS HAVE METER HOOKED–UP AND IN POSITION TO TAKE MEASUREMENTS. IF NOT MAKE SURE THE PROBE END IS NOT TOUCHING ANYTHING. AS SOON AS THE METER MEASURE HANDLE IS LIFTED THERE IS VOLTAGE POTENTIAL ACROSS THE METER.



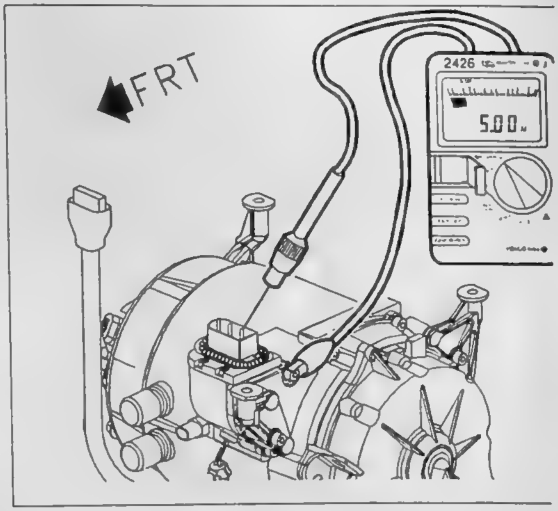
PSMELC68362AA

6. Lift the meter measure handle on the digital insulation tester. Notice the high voltage red LED is on in the right top corner. This indicates high voltage is present on tool.

Touch the line probe to each of the motor phases, make sure you are not touching the connector housing. View and record each measurment.

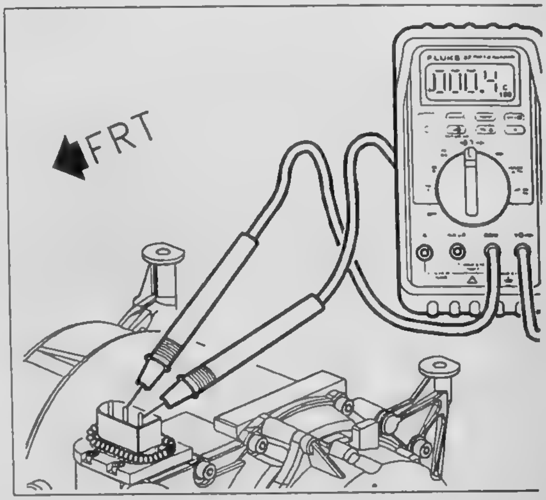
Readings should be between 5MΩ (Mega-ohms) and infinity (OL, OL = Open circuit).

If reading is not within the indicated range replace the Drive motor.

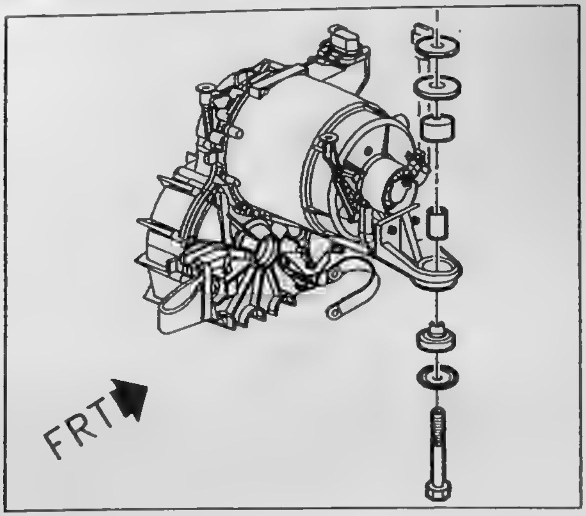


PSMPEN68:

10. Next measure the resistance on each phase using a digital multimeter (DVOM). Place the tester switch to the continuity position.
11. Place the ground probe on phase one and touch line probe to phase 2 and 3, place the ground probe on phase 2 and touch the line probe to phase 3; watch and record each reading. Make sure when you are taking the readings you do not contact the connector housing.
12. Readings should be less than 1.0 ohms.
13. If readings are not within the indicated range replace drive motor.

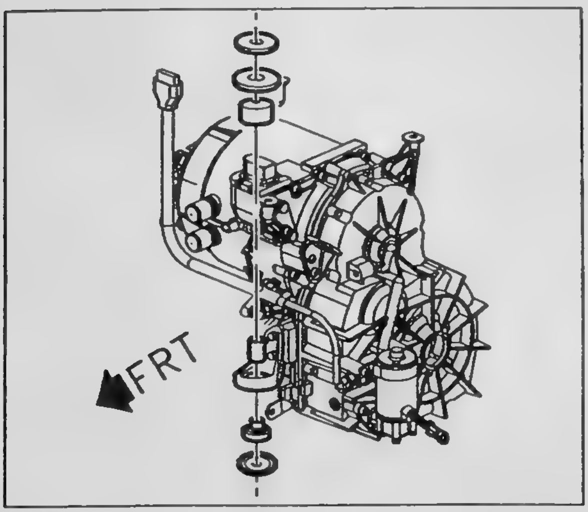


PSMPEN62



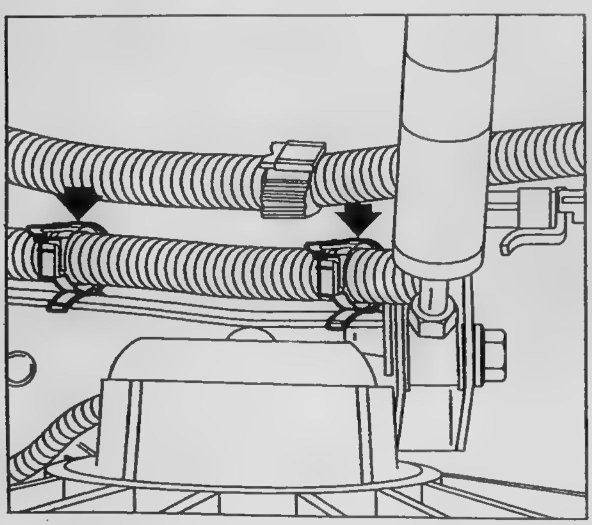
PSMGCH65837AA

16. Remove the side motor mount to chassis bolt.



PSMGCH65838AA

17. Remove the front motor mount to chassis bolt.
18. Lower vehicle.
19. Remove the left outlet duct from underhood.

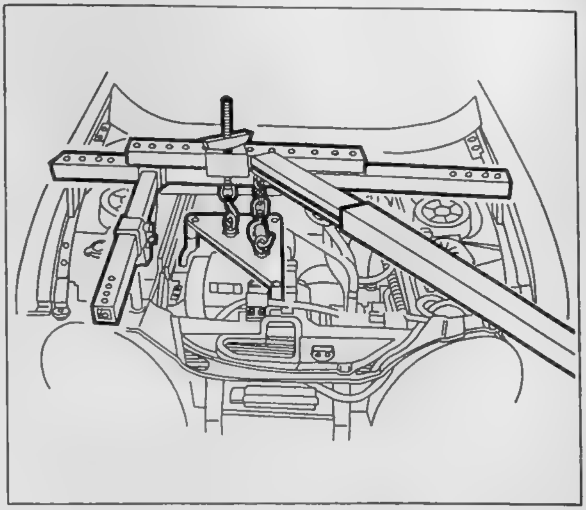


PSMPEN66368AA

20. Remove the harness from the two clips on the front rail to gain access to the front mount bolts.

Connect a engine hoist to left I-bolt on the drive motor lift plate. Raise the engine hoist until there is tension on the chain.

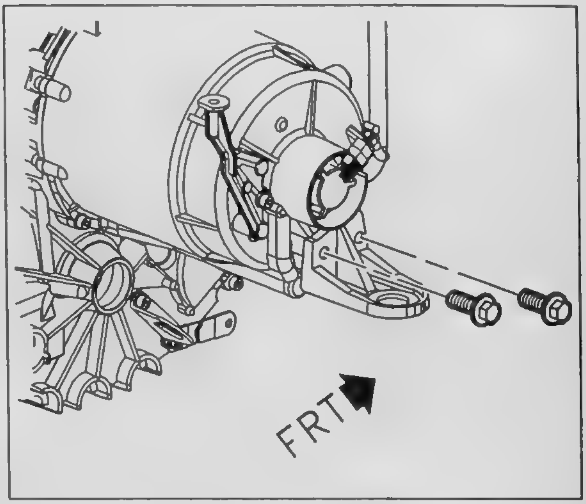
Remove the motor support bar assembly.



PSMPEN66369AA

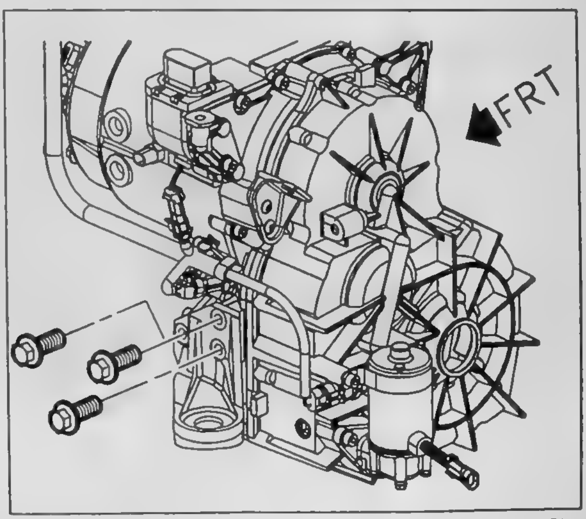
23. Remove the two motor mount bolts on the side motor mount and remove mount bracket. Disconnect the speed/direction sensor connector for better access to the bolts.

IMPORTANT: For better access to motor mount bolts it may be necessary to reposition motor using the engine hoist.



PSMPEN66371AA

24. Remove the three motor mount bolts on the front motor mount and remove the mount bracket.
25. Carefully lift the drive motor upward out of the motor compartment making sure the oil pump clears the air conditioning and the power steering lines.



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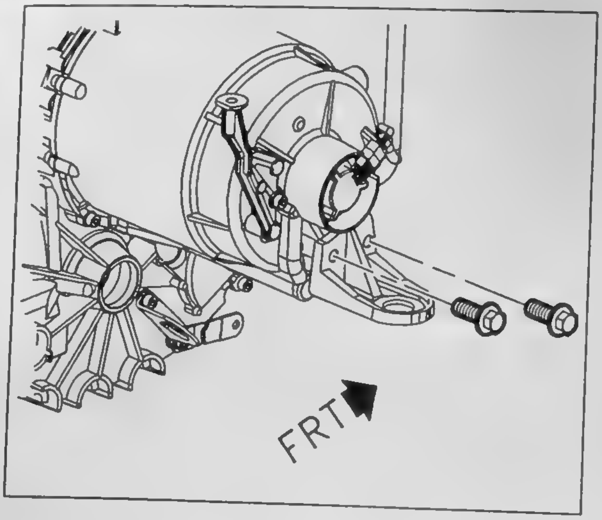


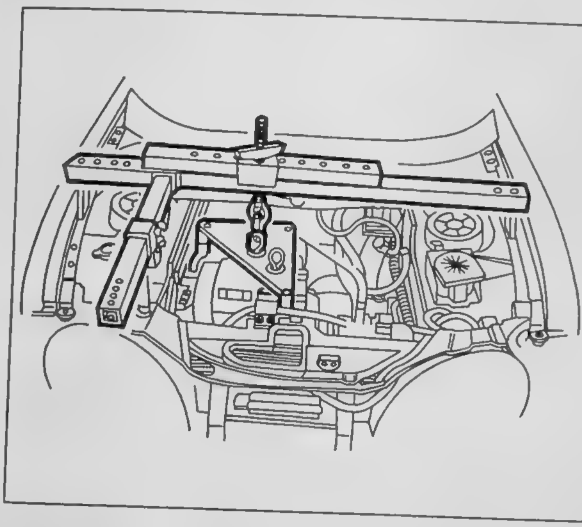
PSMPEN66371AA

INSTALLATION

1. Move the drive motor over the motor compartment and slowly lower drive motor to align with motor mount locations.

NOTICE: Be careful not to damage the air conditioning or power steering lines when installing the motor in the motor compartment.

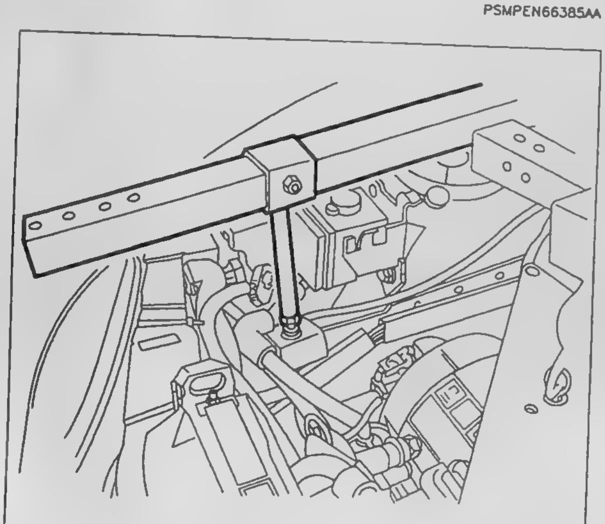
2. Install the front and side motor mount brackets. It may be necessary to insert the front motor mount from below the fascia and rest it on the stabilizer bar until the bolts can be installed from the top.
   a. Front motor mount: **100 N•m (75 ft–lbs)**
   b. Side motor mount: **100 N•m (75 ft–lbs)**
3. Inspect all mounts to ensure they are centered.



PSMPEN66385AA

4. Install the drive motor support bar assembly SA9105E.
   a. Assemble support bar using EV9708E adapter kit or equivalent.

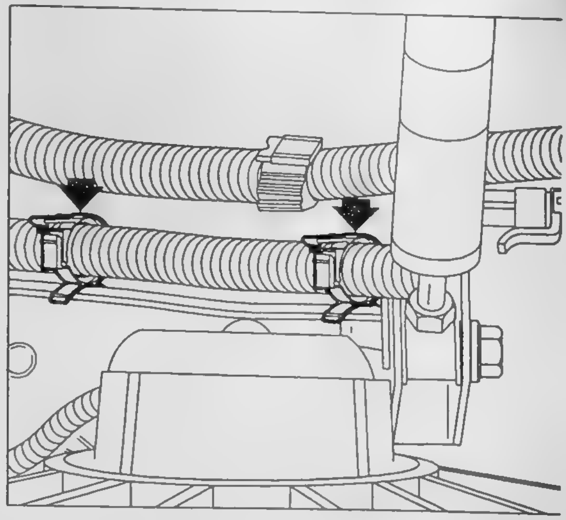
NOTICE: The cross bars on the drive motor support bar fixture have more than one setting. The setting locations are marked on the bar and shown in the illustration. Make sure the attachment pin and hooks are installed in the proper location to prevent damage.



PSMGCH66574AA

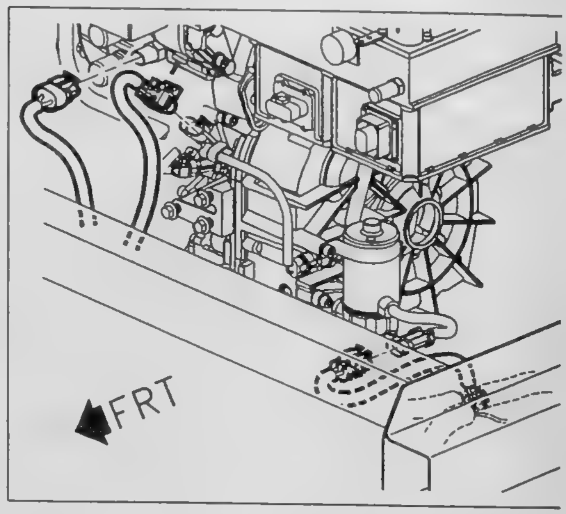
   b. Place the drive motor support bar in vehicle as shown. Place the support bar feet on the outer edge of the shock tower.
   c. Position stabilizer foot per illustration.
   d. Connect bar hook to the right I-bolt on the drive motor support plate.
5. Adjust hook stabilizer until there is tension.
6. Remove the engine hoist.

Install harness to front rail.



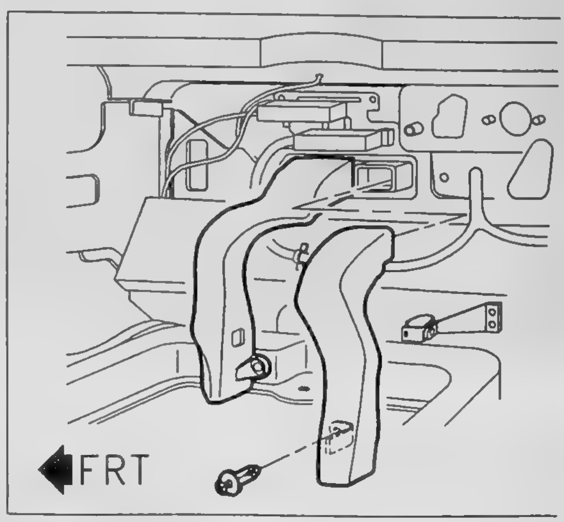
PSMPEN6636E

8. Install the cooling temperature sensor, oil pump and the 3-way PRND connector.

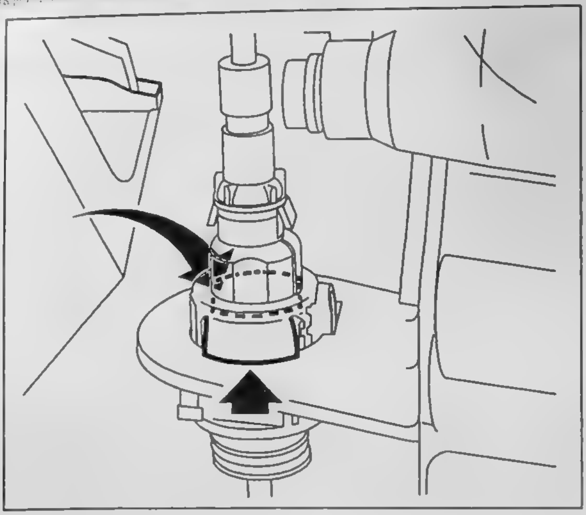


PSMPEN6676:

9. Install the left duct to the front of dash.
10. Raise the vehicle on a hoist. (Refer to "Hoisting, Jacking, Lifting, and Support" section in this manual.)
11. Install all motor mount bolts and torque:
    - Front motor mount: **100 N•m (75 ft–lbs)**
    - Side motor mount: **65 N•m (48 ft–lbs)**
    - Rear motor mount: **85 N•m (63 ft–lbs)**

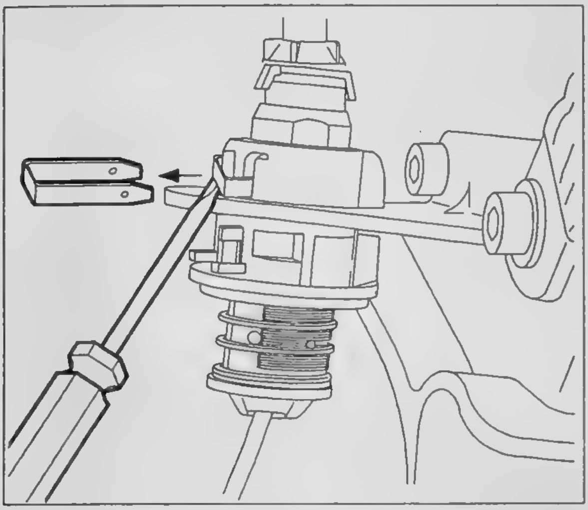


PSMPEN6638·



PSMPEN66367AA

12. Install PRND cable to drive motor bracket.
13. Install PRND cable to lever on PRND switch.



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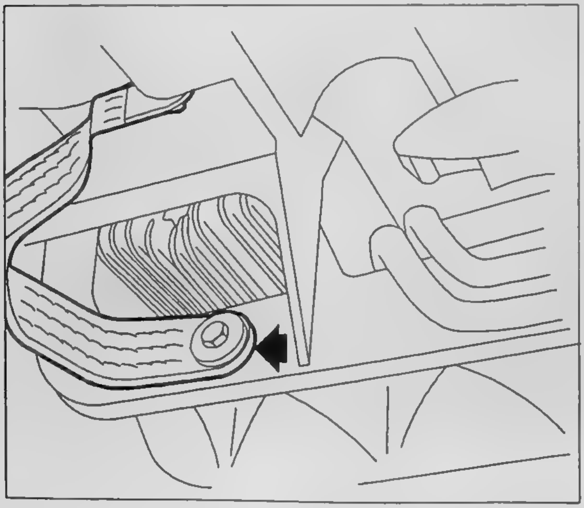
14. Install shift cable clip.



PSMPEN66387AA

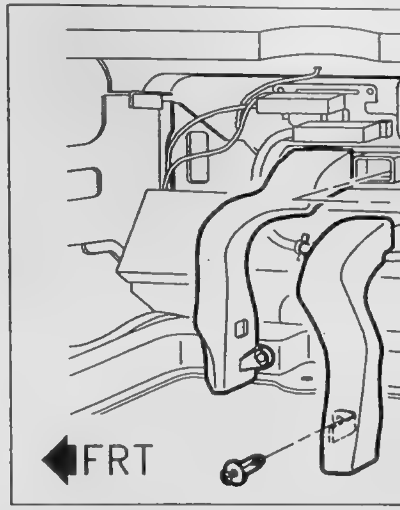
15. Install ground strap to cradle.

Torque: **30 N•m (22 ft–lbs)**

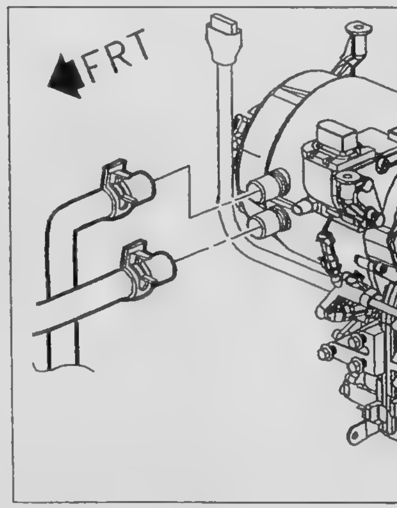
16. Remove axle plugs from the drive motor.
17. Install drive axles. (Refer to "Drive Axle" installation procedure in this manual.)

18. Install push pin on outlet duct.

19. Lower vehicle.



20. Install the coolant hoses to the drive motor.



21. Install front motor shock absorber and torque.

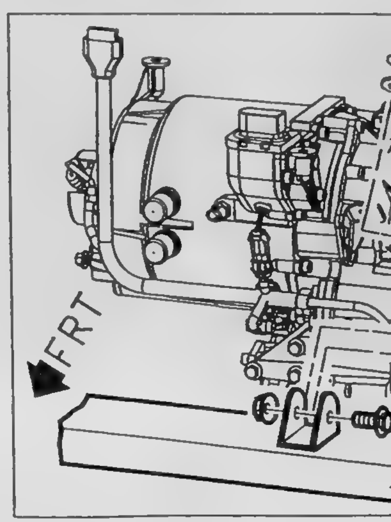
- Front motor shock absorber to drive motor:

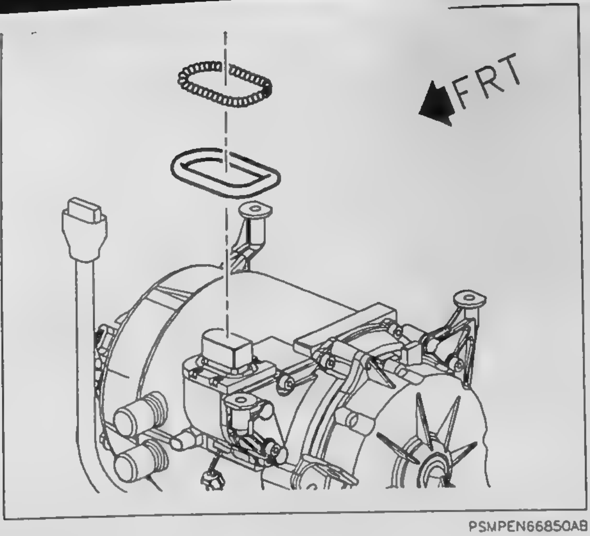
Torque: **7 N•m (62 in–lbs)**

- Front motor shock absorber to body rail bracket:

Torque: **30 N•m (22 ft–lbs)**

22. Remove the drive motor support and lift plate.





PSMPEN66850AB

23. Inspect EMI springs and seal on drive motor blind mate connector.

    a. Replace springs if they are broken or completely smashed.

    b. Replace seal if it is cut or torn.

24. Install the power electronics bay (PEB). (Refer to the "PEB" installation precedure in this manual.)

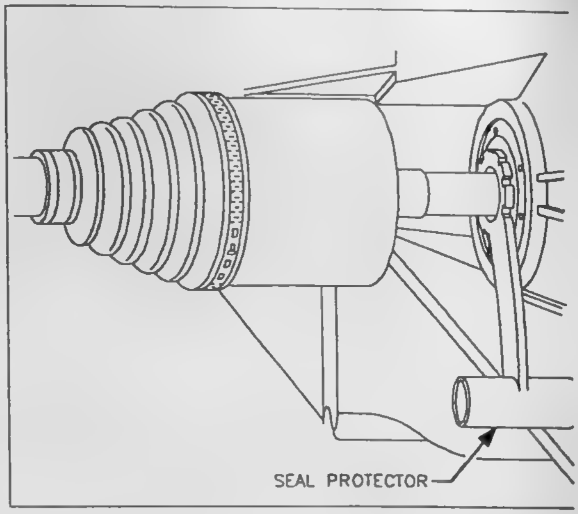
DRIVE AXLE INSTALLATION

NOTICE: When inserting drive axle into gearbox, be careful not to contact oil seal with drive axle splines. The splines can damage the oil seal.

1. Install gear box seal protector SA91112T (or equivalent).

IMPORTANT: Make sure drive axle clip is oriented with opening facing downwards prior to installation into gearbox.

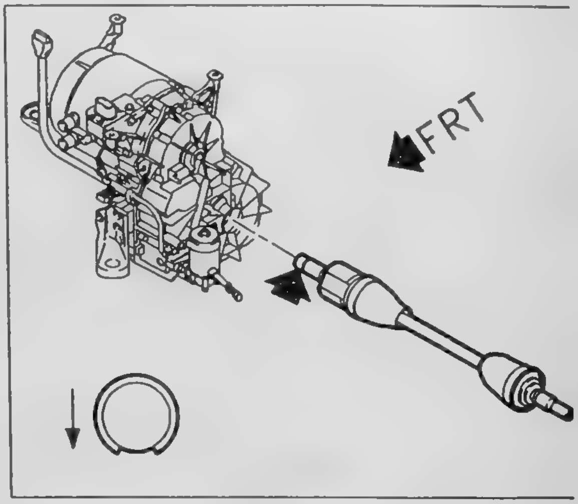
2. Insert drive axle into gearbox.
3. After drive axle splines have safely passed the gearbox oil seal remove seal protector, fully seat drive axle into gearbox.



SMPAT50811

NOTICE: To prevent damage to the CV joint boots, be careful not to allow them to contact other parts during the removal/installation process. Also, never pull on the shaft assembly.

4. Insert outer end of drive axle into the wheel hub. Do not install drive axle-to-hub washer or nut at this time.



PSMGCH65761

NOTICE: Be careful not to allow the lower control arm to contact ball joint seal (boot). Contact may cause the seal to rip, requiring steering knuckle replacement.

5. Install lower ball joint into lower control arm. Install ball stud castle nut.

IMPORTANT: Do not tighten fastener at this time.

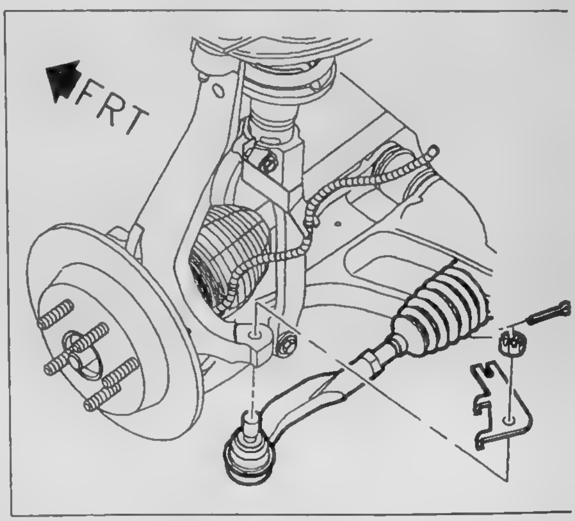
IMPORTANT: The rod end threads must be thoroughly cleaned.

6. Attach tie rod end and wire guard to steering knuckle with castle nut and a new cotter pin.

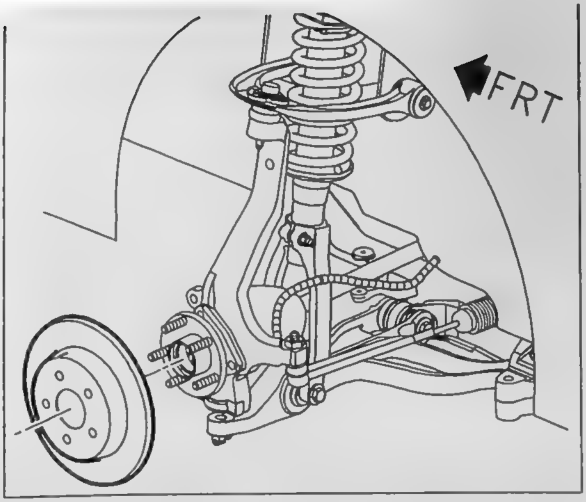
Torque: 23 N•m (17 ft–lbs)

IMPORTANT: If necessary to rotate the castle nut after tightening to align it with the hole in the stud, always tighten the nut to align it; never loosen it.

IMPORTANT: Steering knuckle ball threads must be thoroughly cleaned.



PSMGCH70087



PSMGCH66372AA

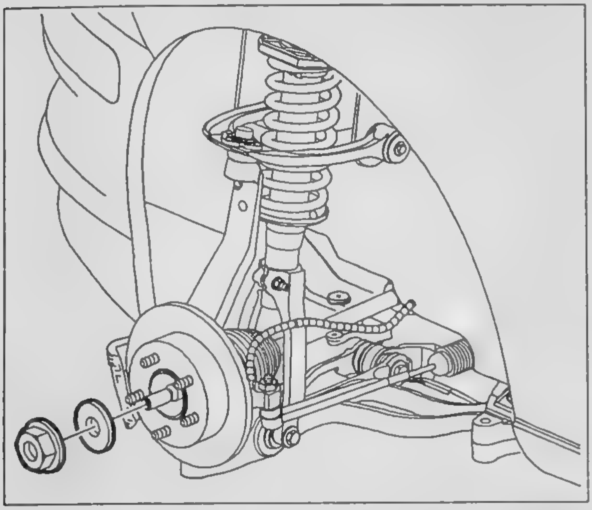
7. Tighten ball joint stud castle nut and install new cotter pin.

Torque: 10 N•m (88 in–lbs) + 120 degrees

IMPORTANT: If it is necessary to rotate the castle nut after tightening to align it with the hole in the stud, always tighten the nut to align it; never loosen it.

8. Install brake rotor onto wheel hub.
9. Install front brake caliper and mounting bracket.

Torque: 110 N•m (81 ft–lbs)



PSMGCH65668AB

NOTICE: Use new nut; torque retention of old nut may not be sufficient.

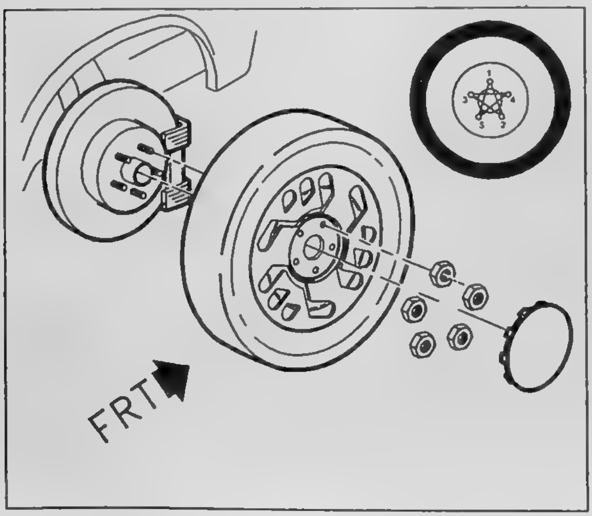
10. Install axle-to-hub washer and NEW nut.

Torque: 260 N•m (192 ft–lbs)

IMPORTANT: When tightening axle nut, have a helper depress brake pedal to prevent axle rotation.

11. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this service manual.)

Torque: 6 N•m (53 in–lbs)



PSMGCH66113AA

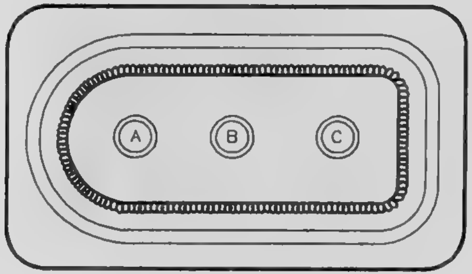
NOTICE: Before installing wheels, remove any rust or corrosion from wheel mounting surfaces and brake rotors. Failure to do so can cause wheel lug nuts to loosen in service.

12. Position wheel onto hub.
13. Install wheel nuts and tighten in a star pattern. Repeat tightening pattern to make sure torque is correct.

Torque: 120 N•m (89 ft–lbs)

14. Install wheel center cap.
15. Lower vehicle from hoist.
16. Check gearbox for correct level of lubricant, if necessary, fill to proper level.
17. Enable high voltage. (Refer to "High Voltage Enable" procedure in this manual.)

DRIVE MOTOR



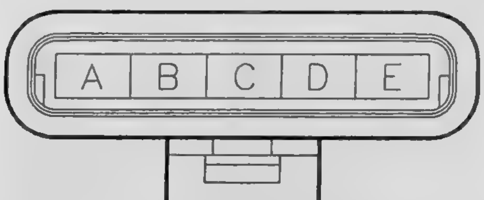
BLINDMATE

PSMELC68242AA

DRIVE MOTOR BLINDMATE				
CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
A				DRIVE MOTOR PHASE A
B				DRIVE MOTOR PHASE B
C				DRIVE MOTOR PHASE C

Location: Underhood Between Power Electronics Bay and Drive Motor

DRIVE MOTOR SPEED / DIRECTION SENSOR



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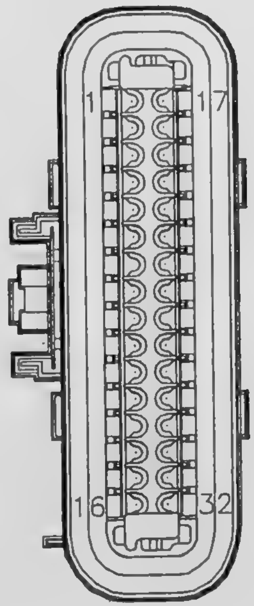
12145555

DRIVE MOTOR SPEED / DIRECTION SENSOR – 12145555				
CAVITY	WIRE COLOR	CIRCUIT NO.	WIRE-SIZE	CIRCUIT FUNCTION
A	BLK	552CA	.50	GROUND
B	YEL/BLK	1558CA	.50	CHANNEL B
C	BARE	514CM	.50	SPEED / DIRECTION SENSOR SHIELD
D	DK BLU/WHT	1557CA	.50	CHANNEL A
E	RED	1673CA	.50	SPEED / DIRECTION SENSOR POWER

Location: Underhood Right Side of Drive Motor

POWER INVERTER MODULE (PIM) – J1



NATURAL
12129025

Location: Underhood, Center of Power Inverter Module

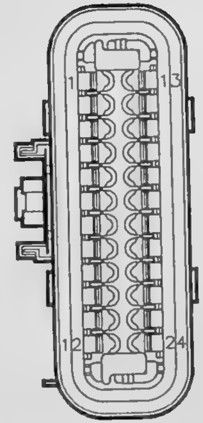
PSMELC67266AB

HARNESS CONNECTOR FACES

POWER INVERTER MODULE – J1 – 12129025

CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
1	BLK / WHT	450R	.35	PCM GROUND
2	WHT	1765	.35	STEERING PUMP SPEED (PSCM IN)
3	DK BLU	179	.35	OIL PUMP CONTROL OUT
4	DK GRN	389	.35	VSS OUT
5	PPL	1885B	.35	SERVICE SOON TELLTALE OUT
6	TAN/WHT	816B	.35	BTSI CONTROL OUT
7	DK BLU	2021	.35	REGEN DISABLE IN
8	DK GRN	2023	.35	CHARGE RECEPTACLE IN
9	DK BLU	84	.35	SET/COAST IN
10	GRA	397	.35	CRUISE ON
11	DK BLU	2038	.35	RETARD ACHIEVED OUT
12	DK GRN	1163	.35	ACCEL PEDAL IN
13	LT BLU	1162	.35	ACCEL PEDAL IN
14	DK BLU	1161	.35	ACCEL PEDAL IN
15	YEL/BLK	1275	.35	ACCEL PEDAL +5V REF
16	TAN	1274	.35	ACCEL PEDAL +5V REF

CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
17	BLK	450P	.35	PSCM GROUND
18	PPL	2017	.35	RETARD REQUEST IN
19	BRN	41C	.35	RUN 1
20	ORN	540	.35	B+
21				
22	TAN	800F	.35	SERIAL DATA
23				
24	BRN	86C	.35	BRAKE SWITCH IN
25	GRA/BLK	87	.35	RESUME/ACCEL IN
26	BRN	241E	.35	RUN 2
27				
28	GRA	1273	.35	ACCEL PEDAL GROUND
29	PPL	1272	.35	ACCEL PEDAL GROUND
30	BRN	1271	.35	ACCEL PEDAL GROUND
31	WHT/BLK	1164	.35	ACCEL PEDAL +5V REF
32				



PSMELC67235AA

GRAY
12129225

Location: Underhood, Center of Power Inverter Module

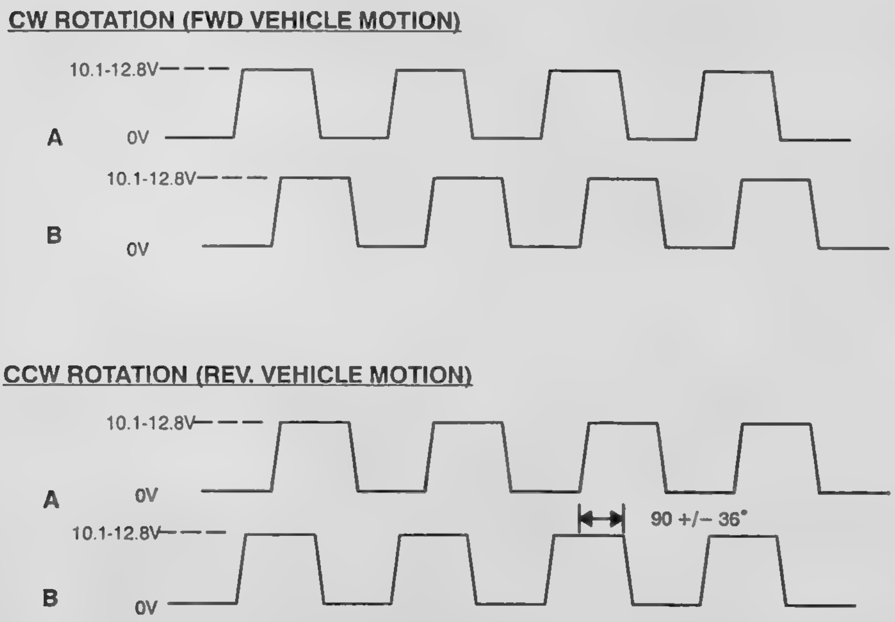
POWER INVERTER MODULE – J2 – 12129225

CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
1				
2				
3				
4	PNK	1798	.50	MOTOR WINDING TEMP SENSOR GROUND
5	DK GRN	37	.50	MOTOR WINDING TEMP SENSOR HI
6	BLK	470BC	.50	PRND SWITCH GROUND
7	WHT	776BC	.50	PRND PARITY
8	GRA	773BC	.50	PRND CHANNEL C
9	YEL	772BC	.50	PRND CHANNEL B
10	BLK/WHT	771BC	.50	PRND CHANNEL A
11	ORN/BLK	1175	.80	OIL PRESSURE SWITCH GROUND
12	TAN/WHT	331	.80	OIL PRESSURE SWITCH HIGH
13	RED	1673CA	.50	DRIVE MOTOR ENCODER POWER
14	DK BLU/WHT	1557CA	.50	DRIVE MOTOR ENCODER A
15	YEL/BLK	1558CA	.50	DRIVE MOTOR ENCODER B
16	BLK	552CA	.50	DRIVE MOTOR ENCODER GROUND
17	BARE	514CM		DRIVE MOTOR ENCODER SHIELD
18				
19				
20				
21				
22				
23				
24				

The speed and direction sensor is located in the right hand side of the drive motor and is attached to the end of the rotor shaft. When the vehicle is placed in the RUN mode the speed and direction sensor receives 12 volts and ground from the propulsion control module (PCM). There are also two signal lines called A and B and a sensor shield between the speed/direction sensor and PCM. When the motor turns two square wave signals are generated, one on A and one on B. These signals are sent to the PCM which passes the signal through to the BCA. The BCA processes the signal and sends back to PCM a PWM signal which is used for motor control and is also sent to the IPC for vehicle speed.

The two channel signals (A and B) are sent to the bias control assembly (BCA). The BCA will decode direction from which signal is leading. If signal A is leading B the vehicle is moving in the forward direction. If signal B is leading A the vehicle is moving in the reverse direction. Shaft speed is calculated from the frequency of this signal. The BCA then takes this information and combines it into one signal which is sent to the PCM. If this signal is greater than 9.1 volts the vehicle is moving in the forward direction and if the signal is 5 volts +/− 2 volts the vehicle is moving in the reverse direction. Shaft speed is calculated by the PCM using the input signal from the BCA.

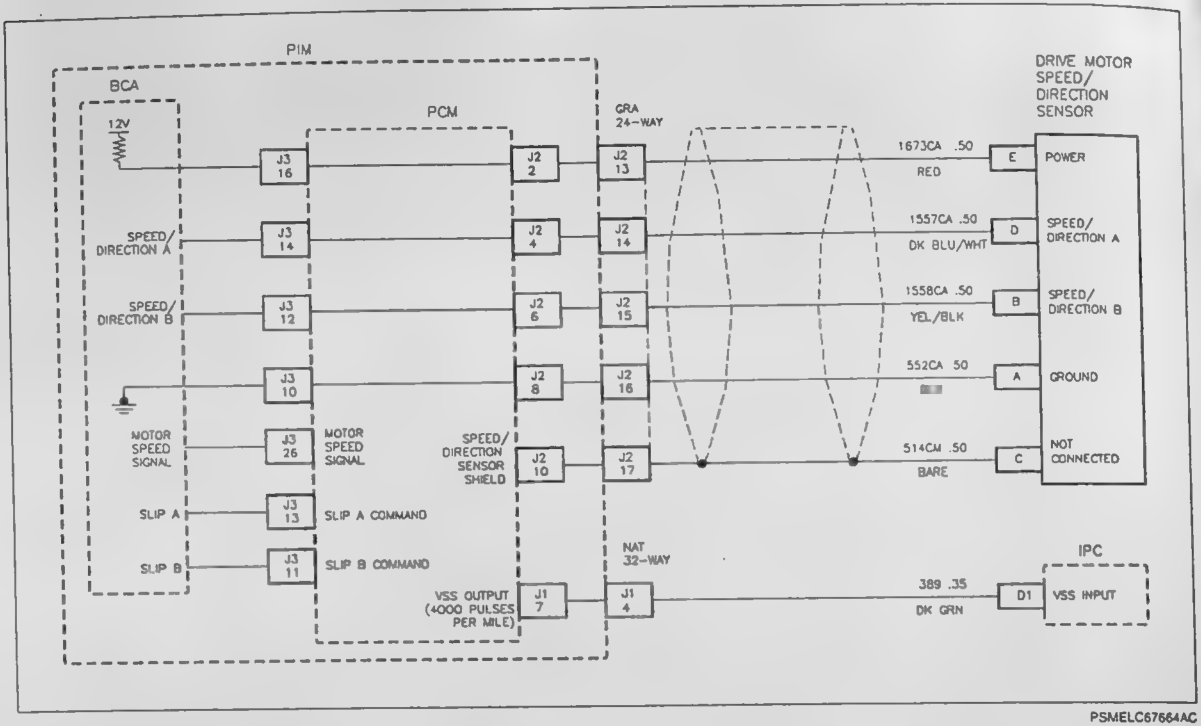
A loss of 12 volt power or ground to the sensor will cause the vehicle to be stuck in creep mode (2 mph max).



Rotation is as viewed from Speed/Direction sensor END of DRIVE MOTOR

DUTY CYCLE: 60% +/− 10%

DTC 007 – VEHICLE SPEED INPUT PULSE RATE TOO HIGH



PSMELC67664AC

VEHICLE SPEED INPUT PULSE RATE TOO HIGH

The propulsion control module (PCM) uses and monitors the motor shaft speed signal for several different functions including vehicle speed signal generation, torque control, and cruise control. The bias control assembly (BCA) generates the speed/direction signal which has one pulse for every pulse of the shaft speed/direction signal. The amplitude of the motor speed direction signal is 5 volts for reverse and 10 volts for forward. The speed/direction sensor is located in the right hand side of the drive motor.

DTC PARAMETERS

The DTC will set any time the PCM sees a pulse rate greater than 34,000 Hz on the speed/direction input. This corresponds to a shaft speed of 16,000 RPM.

ACTION TAKEN BY THE PCM

The SERVICE NOW telltale is illuminated, the DTC is stored and propulsion is disabled.

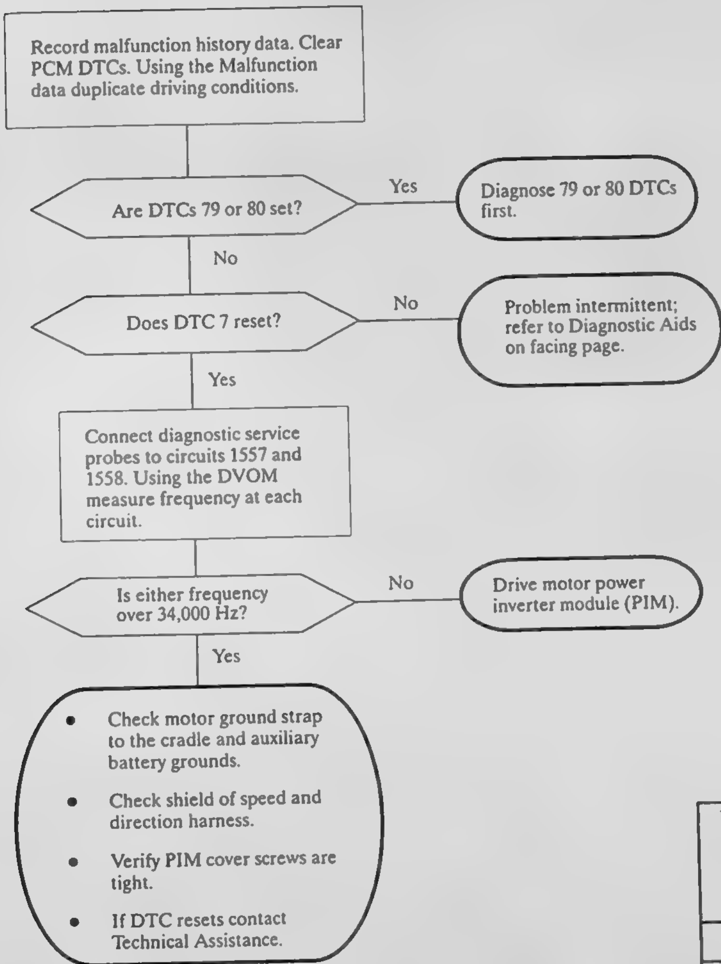
TELLTALE ILLUMINATED:

SERVICE NOW

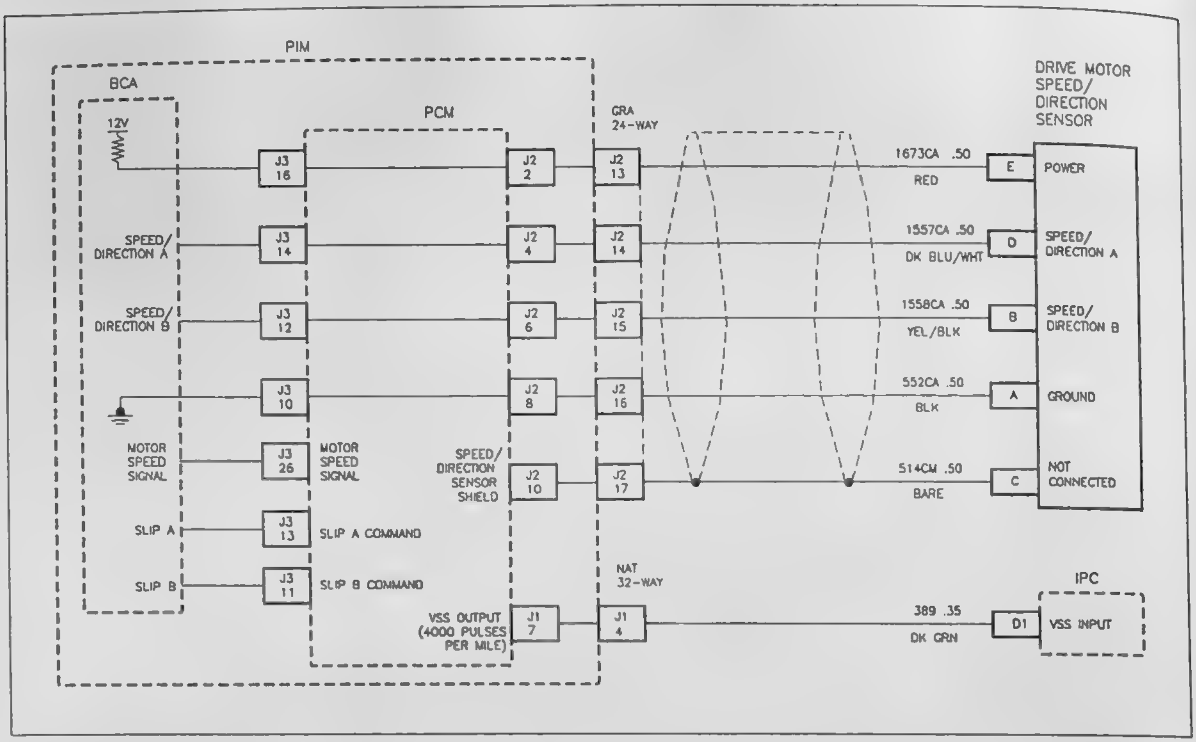
DIAGNOSTIC AIDS

- This code could be caused by over-speed such as going down a hill.
- Check 12 volt speed/direction supply voltage.
- When attempting to diagnose an intermittent

DTC 007
VEHICLE SPEED INPUT PULSE RATE TOO HIGH



Vehicle Speed km/h (mph)	Hz (+/−10%) 40 Hz Scale
0 (0)	0
16 (10)	3000
32 (20)	7200
48 (30)	10,500
64 (40)	14,000
81 (50)	17,200
97 (60)	20,600
112 (70)	24,300
129 (80)	28,300



PSMELC67664AC

VEHICLE SPEED INPUT TOO NOISY

The propulsion control module (PCM) uses and monitors the motor shaft speed signal for several different functions including vehicle speed signal generation, torque control, and cruise control. The bias control assembly (BCA) generates the speed/direction signal which has one pulse for every pulse of the shaft speed/direction signal. The amplitude of the motor speed direction signal is 5 volts for reverse and 10 volts for forward. The speed/direction sensor is located in the right hand side of the drive motor.

DTC PARAMETERS

This DTC will set if the PCM detects a number of shaft speed changes in excess of 2,000 rpm or shaft direction changes in a short period of time, while the shaft speed frequency is greater than 2000 RPM.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale is illuminated, the DTC is stored, regen braking and cruise control are disabled. If the fault clears, the telltale will turn off 10 seconds after two minutes are complete and the PCM will resume normal operation.

RELATED DTCS

PCM 43, 76, 79, 80

TELLTALE ILLUMINATED:

SERVICE SOON

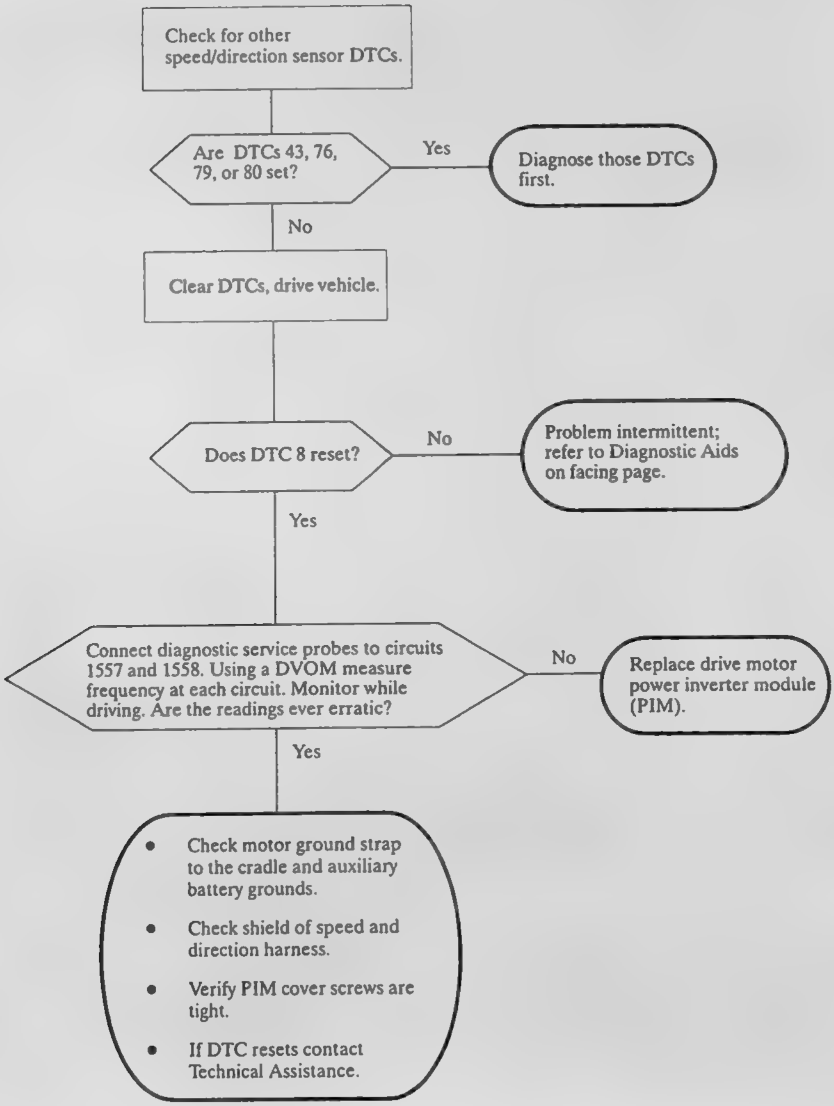
DIAGNOSTIC AIDS

- This failure could be caused by a speed/directon BCA problem, or problems with shielding or ground integrity of the speed/direction sensor.
- Speed/Direction 12 volt supply failure could cause numerous problems.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

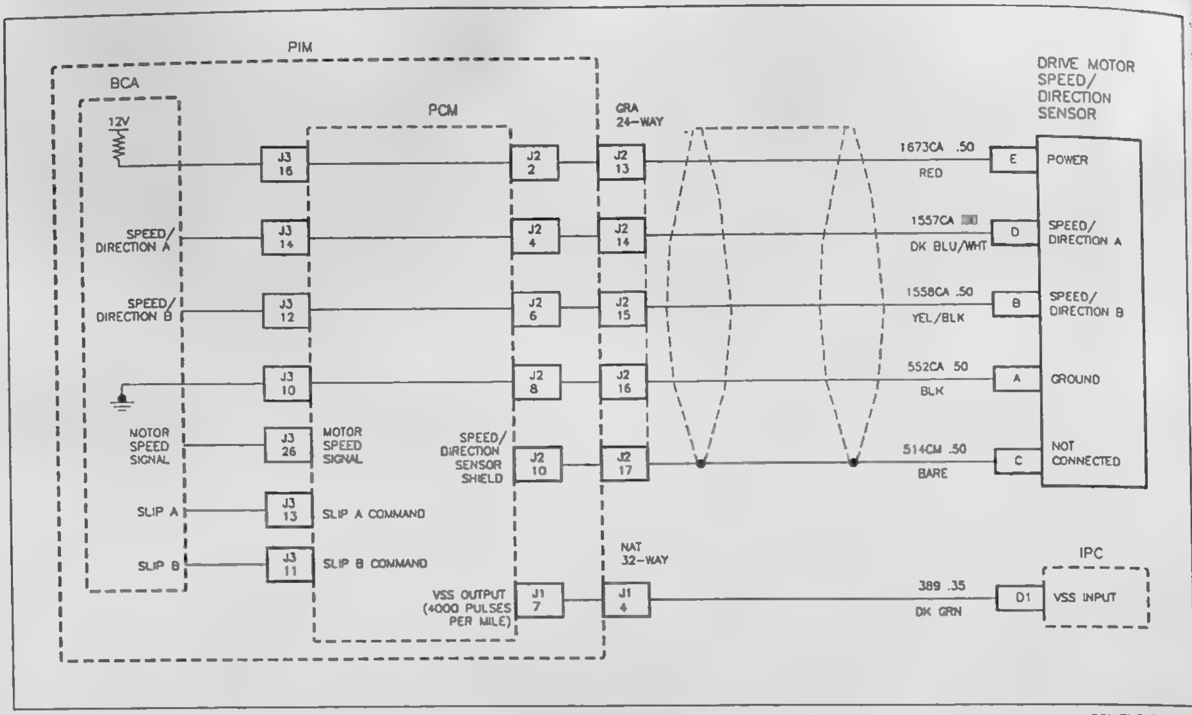
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

DTC 008
VEHICLE SPEED INPUT TOO NOISY



DTC 074 – EXCESSIVE SHAFT SPEED VARIATION DETECTED



PSMELC67664AC

EXCESSIVE SHAFT SPEED VARIATION DETECTED

The propulsion control module (PCM) uses and monitors the speed/direction sensor shaft speed signal for several different functions including vehicle speed signal generation, torque control, and cruise control. The bias control assembly (BCA) generates the speed/direction signal which has one pulse for every pulse of the shaft speed/direction signal. The amplitude of the speed/direction signal is 5 volts for reverse and 10 volts for forward. The PCM monitors this signal in order to ensure stability of the control system.

DTC PARAMETERS

The DTC will set when excessive periodic variation of the shaft speed input indicates an unstable control system. The PCM is looking for many small changes (jumps) of about 200 rpm (430 Hz).

ACTION TAKEN BY PCM

This DTC is set, the SERVICE NOW telltale is illuminated, and propulsion is disabled. This fault is latched for the duration of the ignition cycle.

RELATED DTCS

PCM 7, 8, 43, 76, 80

TELLTALE ILLUMINATED:

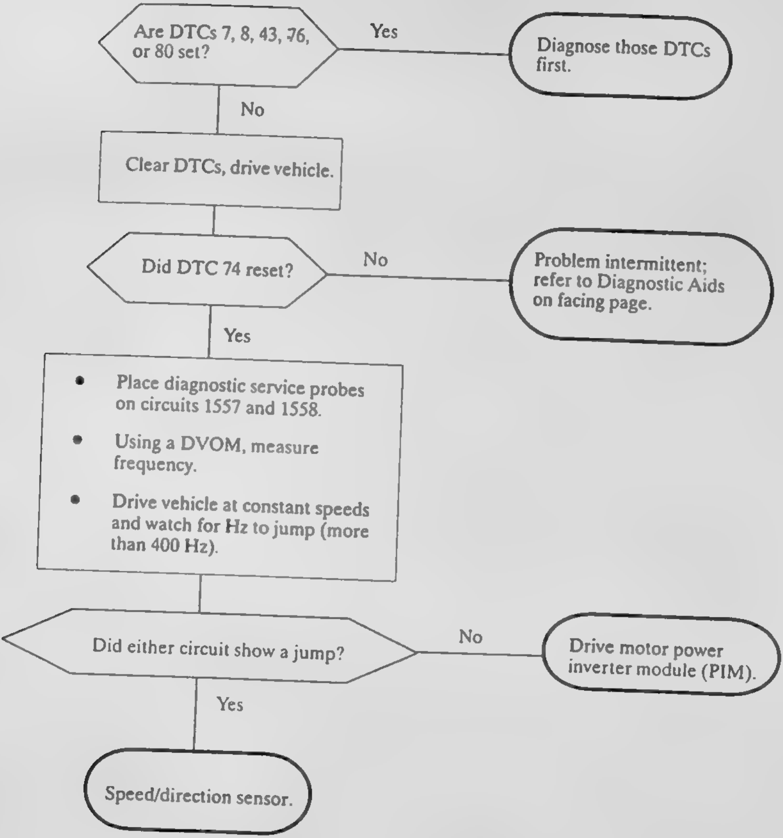
SERVICE NOW

DIAGNOSTIC AIDS

- This could be caused by a failure of the BCA or the PCM.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

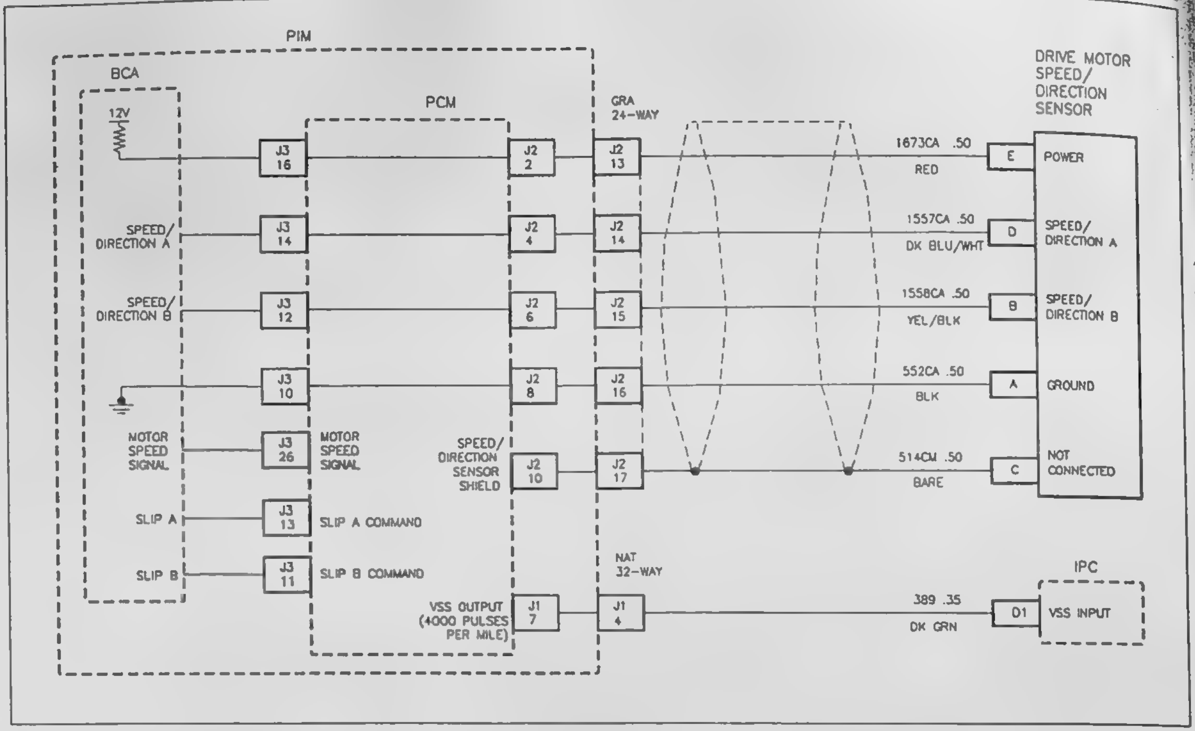
* Select Malfunction History from the Scan tool PCM menu.

DTC 074
EXCESSIVE SHAFT SPEED VARIATION



Vehicle Speed kn/h (mph)	

DTC 076 – BCA SPEED/DIRECTION SIGNAL FAULT



PSMELC67664AC

BCA SPEED/DIRECTION SIGNAL FAULT

The propulsion control module (PCM) sends the speed/direction signal to the bias control assembly (BCA). The BCA monitors the signal for a one to one ratio.

DTC PARAMETERS

This DTC will set anytime BCA detects six pulses on one channel but not on the other channel (channel A and B).

ACTION TAKEN BY THE PCM

This DTC is set, the SERVICE NOW telltale illuminated and propulsion is disabled. If the condition is cleared and Run is cycled Off and On, propulsion is restored.

RELATED DTCS

PCM 7, 8, 43, 78, 79, 80

TELLTALE ILLUMINATED:

SERVICE NOW

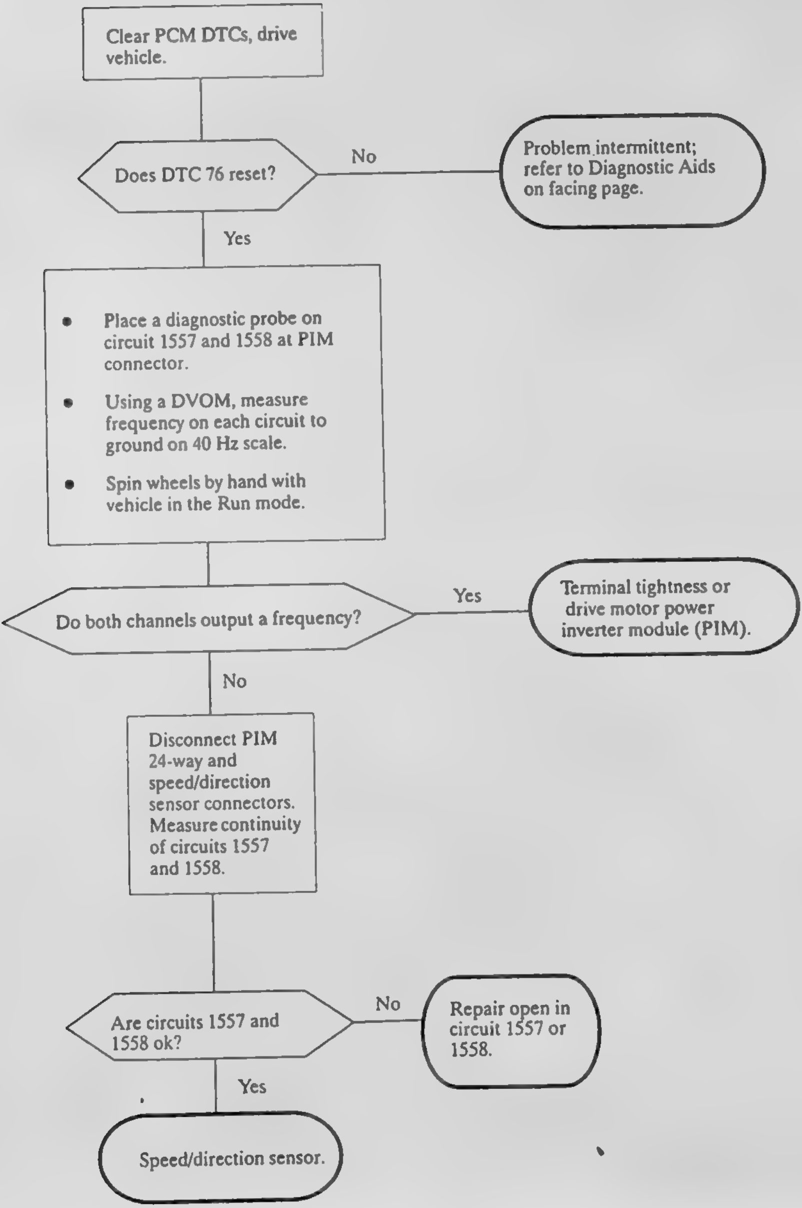
DIAGNOSTIC AIDS

- Drive vehicle. If DTC sets at a specific speed or motor current run a new wire for each encoder channel and see if problem goes away.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

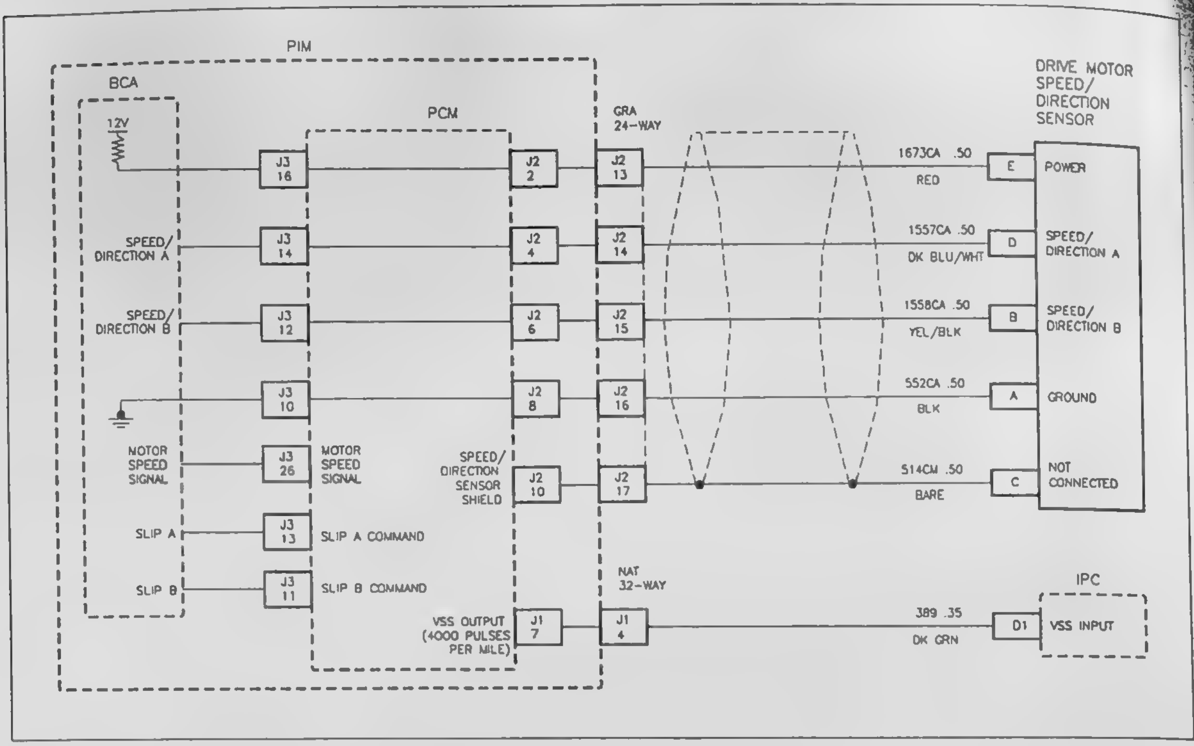
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the

DTC 076
BCA SPEED/DIRECTION SIGNAL FAULT



DTC 078 – DIFFERENCE IN PCM AND BTCM SHAFT SPEED READS



PSMELC67664AC

DIFFERENCE IN PCM AND BTCM SHAFT SPEED READS

The propulsion control module (PCM) uses and monitors the motor shaft speed signal for several different functions including vehicle speed signal generation, torque control, and cruise control. The bias control assembly (BCA) generates the speed/direction signal which has one pulse for every pulse of the shaft speed/direction signal. The amplitude of the motor speed direction signal is 5 volts for reverse and 10 volts for forward. The speed/direction sensor is located in the right hand side of the drive motor. The BTCM monitors wheel speeds and transits data over serial data to the PCM.

DTC PARAMETERS

PCM shaft speed input reads zero but BTCM (serial data) wheel speed reads greater than 5 mph.

ACTION TAKEN BY THE PCM

The DTC is set, the SERVICE NOW telltale is illuminated and propulsion is disabled for the ignition cycle.

RELATED DTCS

PCM 7, 8, 43, 76, 80

TELLTALE ILLUMINATED

SERVICE NOW

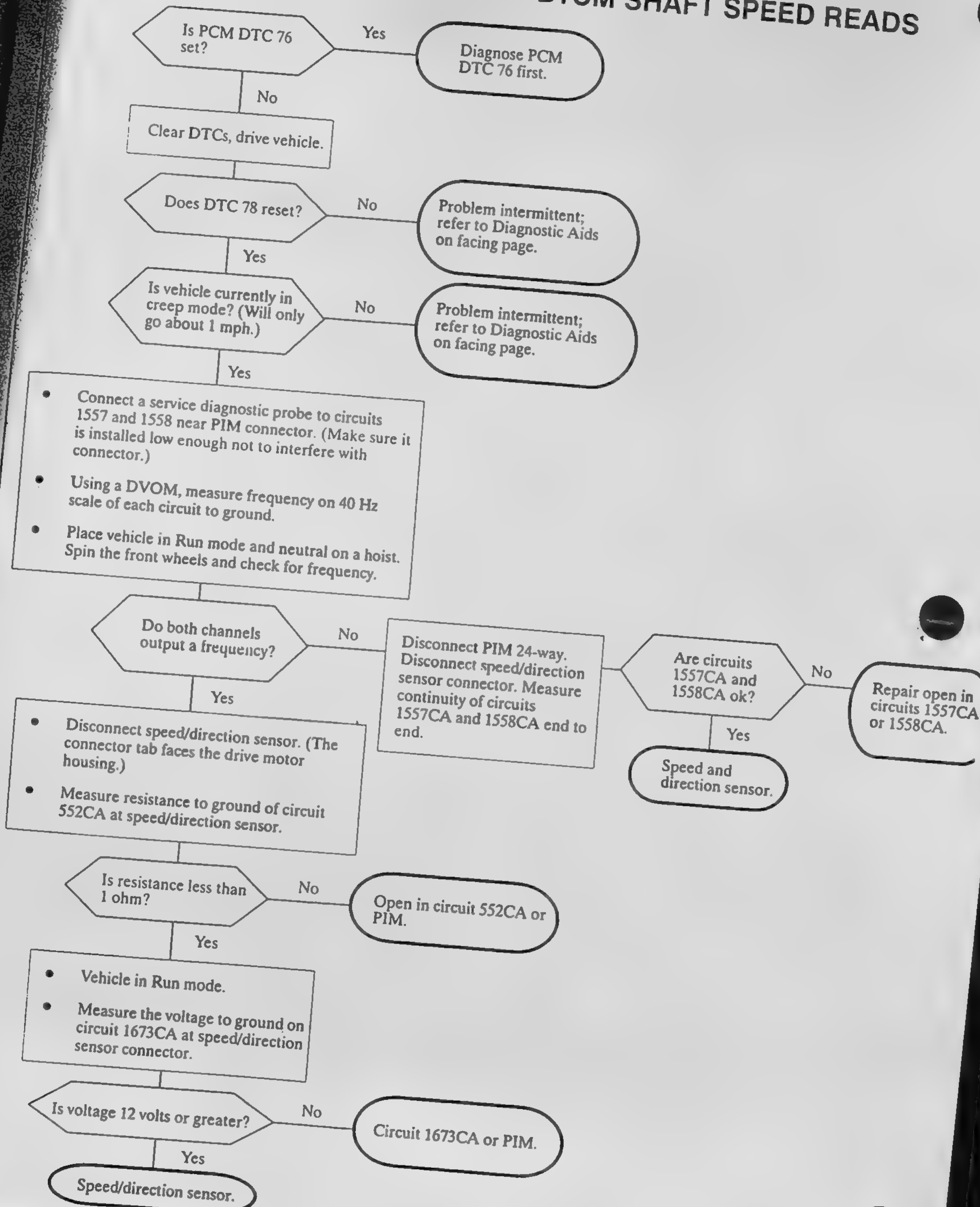
DIAGNOSTIC AIDS

- If DTC 78 is set in history and vehicle is stuck in creep mode (approximately 1 mph), this most likely is caused from a loss of power or ground to the speed/direction sensor, loss of BOTH speed/direction signals A and B or a bad speed/direction sensor. Refer to symptom diagnostic chart "Vehicle Moves In Creep Mode Only."
- The PCM receives from the BTCM a serial data copy of wheel speed to compare this to shaft speed.
- If the speed signal goes to zero PCM will check BTCM wheel speed. If BTCM wheel speed is greater than five mph the PCM will set this DTC.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

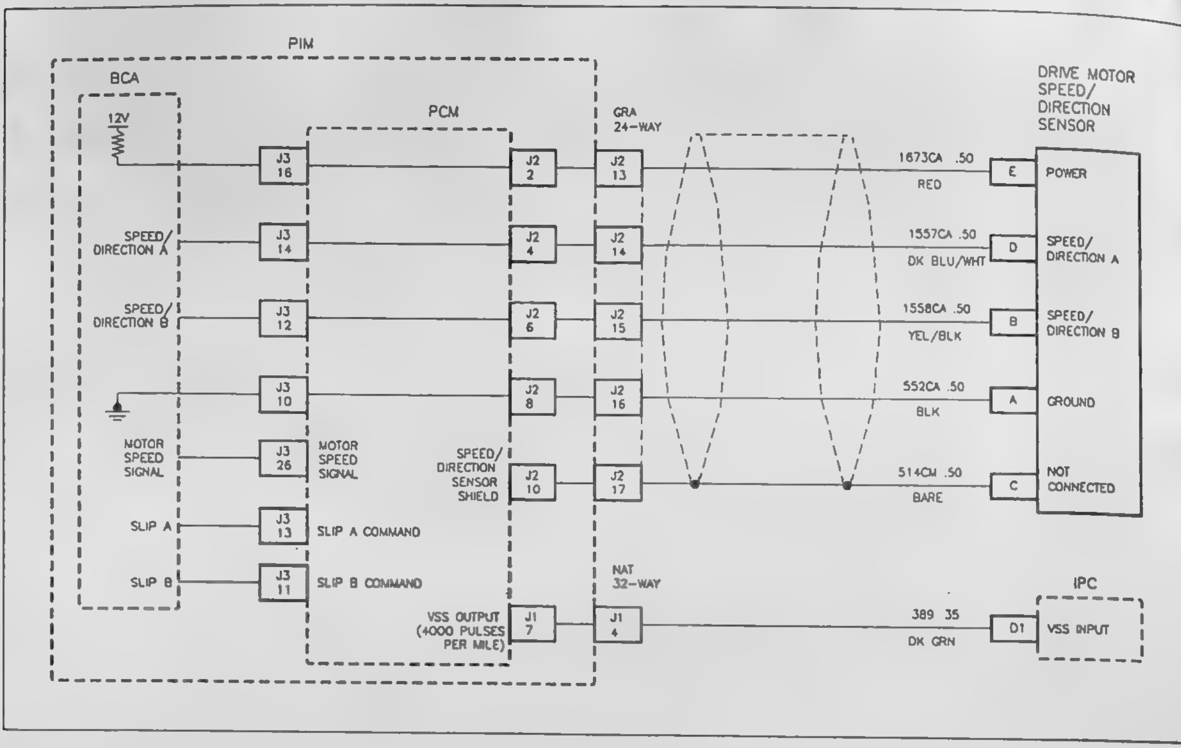
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

DTC 078
DIFFERENCE IN PCM AND BTCM SHAFT SPEED READS



DTC 079 – SHAFT DIRECTION INPUT CHANGE WHILE VEHICLE WAS MOVING



PSMELC67664AC

SHAFT DIRECTION INPUT CHANGE WHILE VEHICLE WAS MOVING

The propulsion control module (PCM) uses and monitors the motor shaft speed signal for several different functions including vehicle speed signal generation, torque control, and cruise control. The bias control assembly (BCA) generates the speed/direction signal which has one pulse for every pulse of the shaft speed/direction signal. The amplitude of the motor speed direction signal is 5 volts for reverse and 10 volts for forward. The speed/direction sensor is located in the right hand side of the drive motor.

DTC PARAMETERS

This DTC will set if the direction signal changes many times in one second below 12 mph.

ACTION TAKEN BY THE PCM

The SERVICE NOW telltale is illuminated, the DTC is set and propulsion is disabled.

RELATED DTCS

PCM 8, 43, 76, 80

TELLTALE ILLUMINATED:

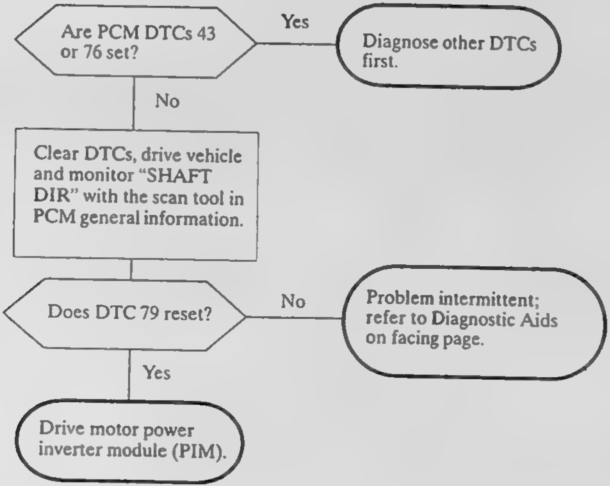
SERVICE NOW

DIAGNOSTIC AIDS

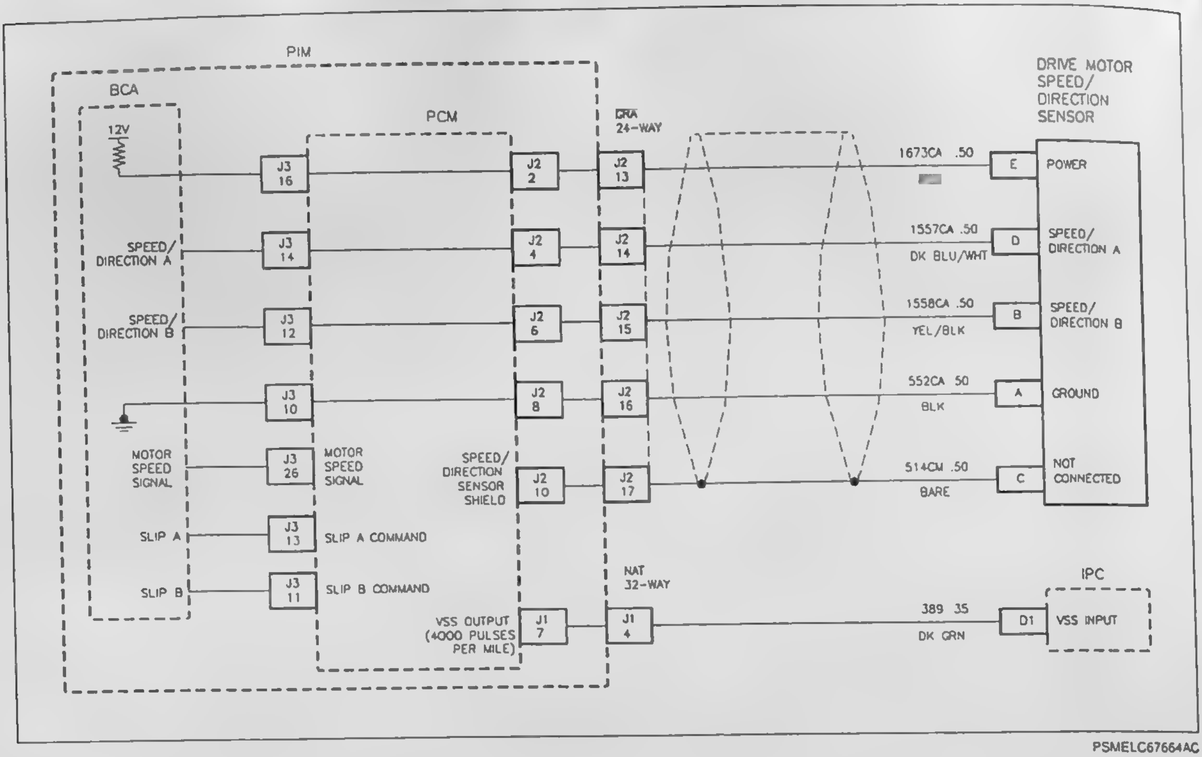
When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

DTC 079
SHAFT DIRECTION INPUT CHANGE WHILE VEHICLE WAS MOVING



DTC 080 – SHAFT SPEED READS "ZERO"



PSMELC67664AC

SHAFT SPEED READS "ZERO"

The propulsion control module (PCM) uses and monitors the motor shaft speed signal for several different functions including vehicle speed signal generation, torque control, and cruise control. The bias control assembly (BCA) generates the speed/direction signal which has one pulse for every pulse of the shaft speed/direction signal. The amplitude of the motor speed direction signal is 5 volts for reverse and 10 volts for forward. The speed/direction sensor is located in the right hand side of the drive motor.

DTC PARAMETERS

This DTC will set anytime shaft speed is greater than 12 mph and drops to zero in 250 milliseconds.

ACTION TAKEN BY THE PCM

The SERVICE NOW telltale is illuminated, this DTC is set, and propulsion is disabled.

RELATED DTCS

PCM 8, 43, 76, 79

TELLTALE ILLUMINATED:

SERVICE NOW

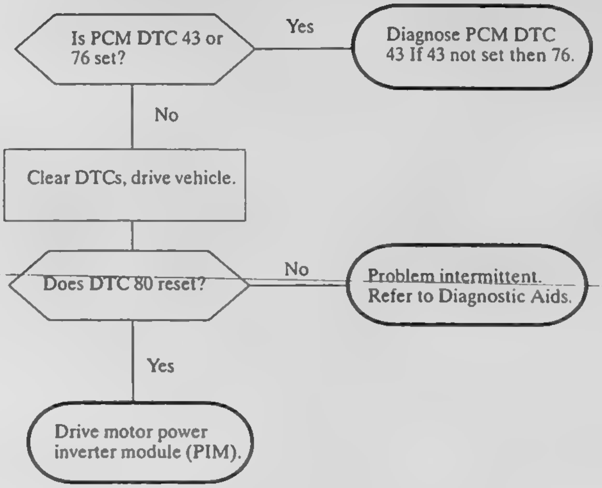
DIAGNOSTIC AIDS

- If DTC 80 is in history and the vehicle is in creep mode, refer to "NO DTCs and vehicle will not move faster than 1–2 mph."
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

DTC 080
SHAFT SPEED READS "ZERO"



PRND SWITCH

The power inverter module (PIM) will check PRND selection inputs, service brake status, drive motor speed/directional sensor shaft rate and direction, and charge connection status based on the chart below, to select the valid PRND and BTSI modes to command.

PRND REQUEST	SERVICE BRAKE SWITCH	BTSI THRESHOLD SPEED > 5 MPK	CHARGE CONNECTION PRESENT	BTSI
PARK	ON	NO	TRUE	LOCK
PARK	ON	NO	FALSE	UNLOCK
PARK	ON	YES	TRUE	LOCK
PARK	ON	YES	FALSE	UNLOCK
PARK	OFF	NO	TRUE	LOCK
PARK	OFF	NO	FALSE	LOCK
PARK	OFF	YES	TRUE	LOCK
PARK	OFF	YES	FALSE	UNLOCK
REVERSE	–	–	–	UNLOCK
NEUTRAL	–	–	–	LOCK
DRIVE	–	–	–	LOCK
ERROR	–	–	–	UNLOCK

PRND SWITCH (PARK/NEUTRAL SWITCH)

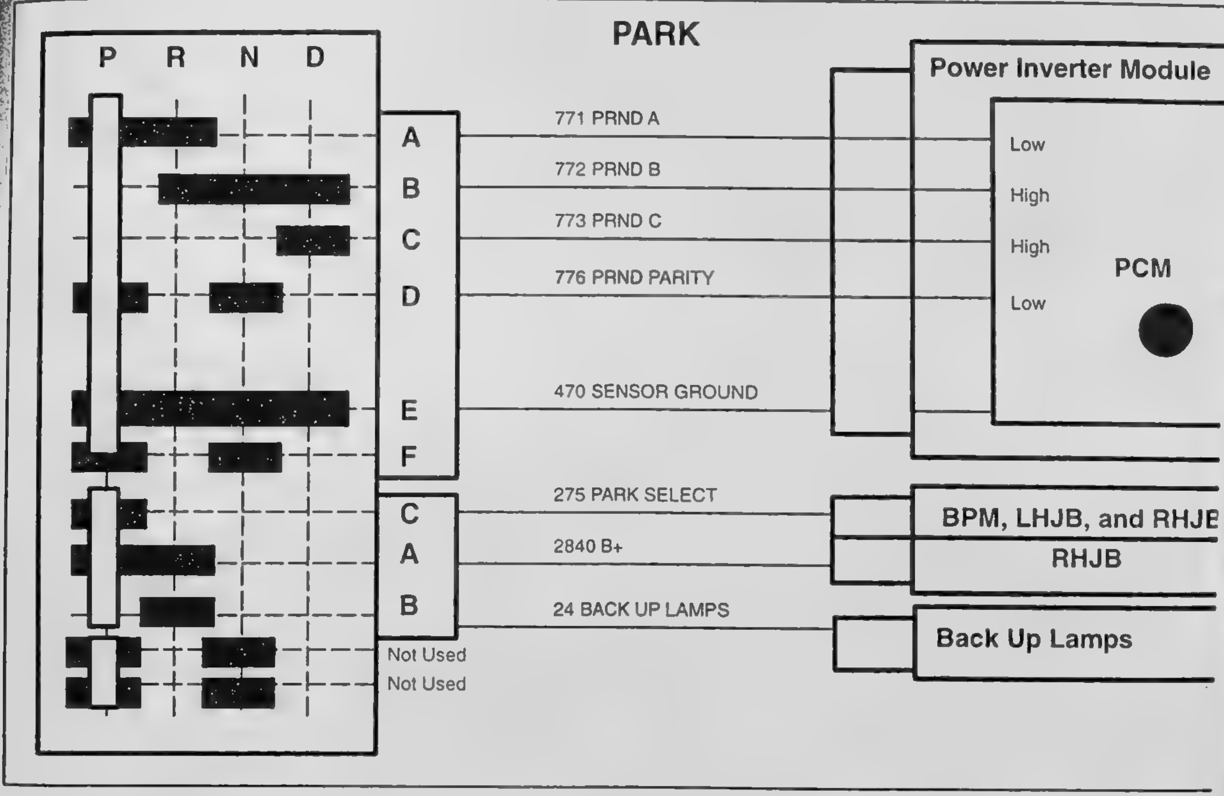
The PRND switch indicates the position of park, reverse, neutral and drive locations. When the shift lever is moved the PRND switch arm is moved by a cable attachment and the new position is read by the PCM. Each position is decoded by four circuits. The circuits are pulled low in various combinations indicating the position of the PRND switch. (Refer to table and schematics following.)

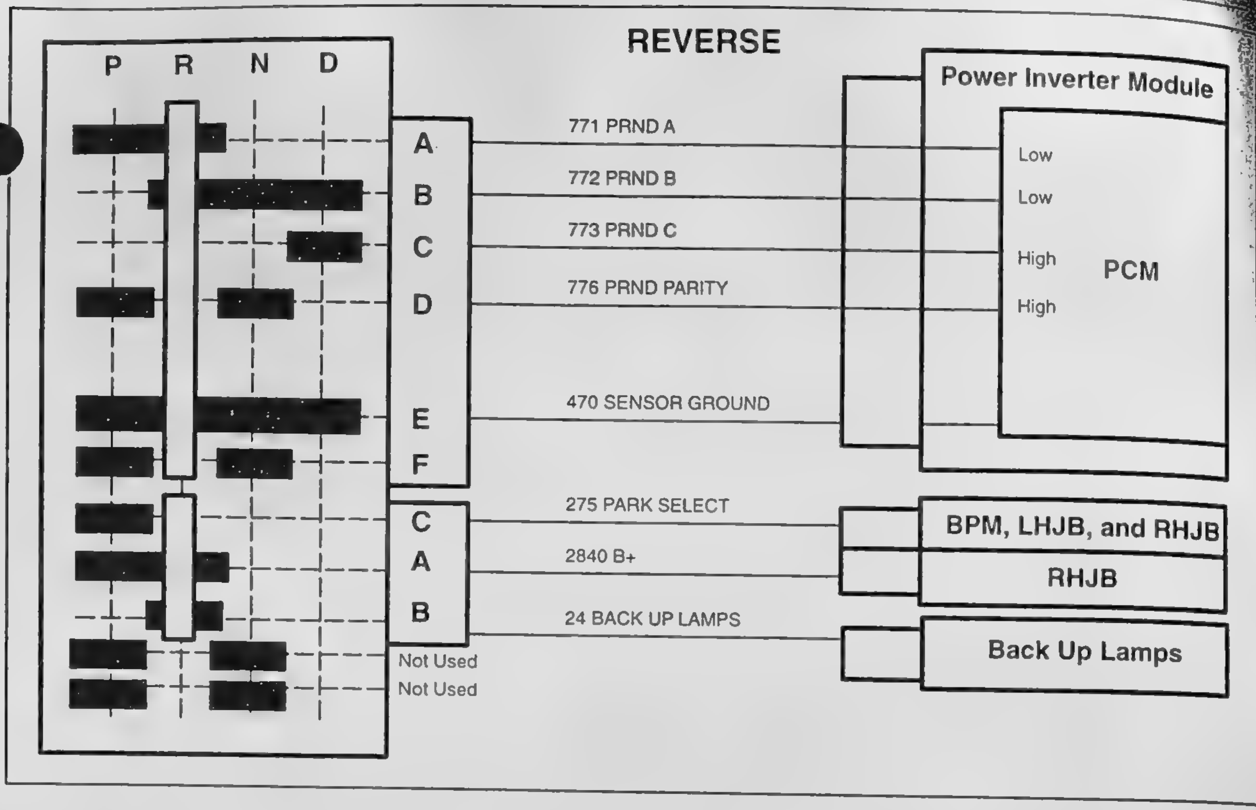
When the shift lever is shifted to the Park position, decoder lines A and D are grounded to the ground circuit with switch and decoder lines B and C remain as high inputs to the PCM.

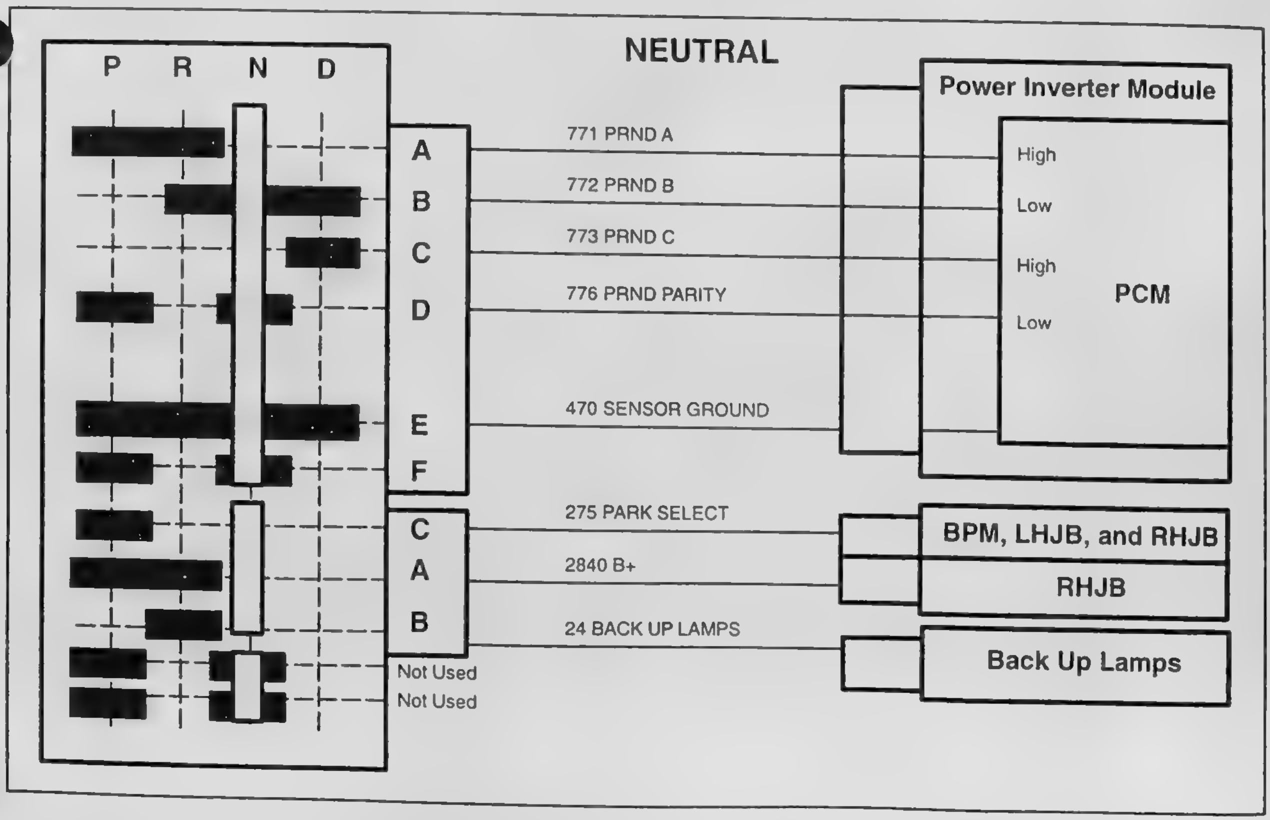
DECODER STATE PINS

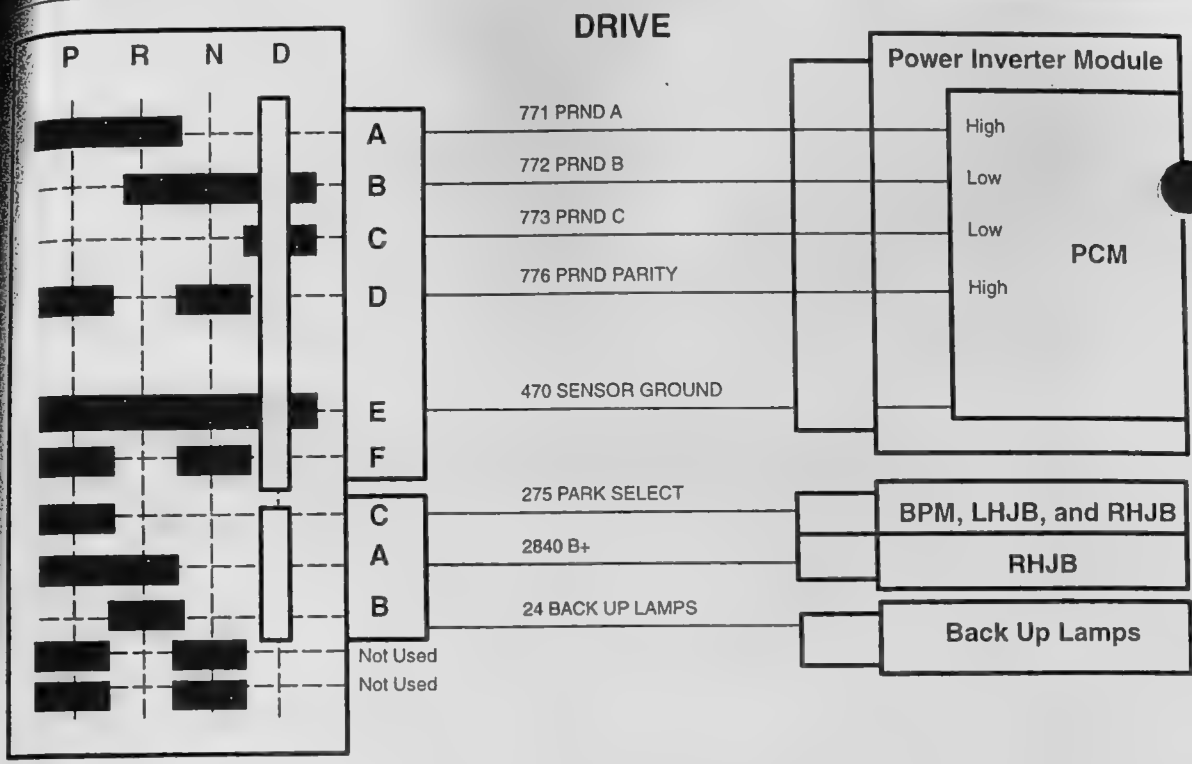
POSITION	A	B	C	D	CIRCUIT
PARK	LOW	HIGH	HIGH	LOW	
REVERSE	LOW	LOW	HIGH	HIGH	
NEUTRAL	HIGH	LOW	HIGH	LOW	
DRIVE	HIGH	LOW	LOW	HIGH	

LOW = GROUND
HIGH = NOT GROUNDED




REVERSE
P R N D
A
B
C
D
E
F
C
A
B
Not Used
Not Used
771 PRND A
772 PRND B
773 PRND C
776 PRND PARITY
470 SENSOR GROUND
275 PARK SELECT
2840 B+
24 BACK UP LAMPS
Power Inverter Module
Low
Low
High
High
PCM
BPM, LHJB, and RHJB
RHJB
Back Up Lamps


NEUTRAL
P R N D
A
B
C
D
E
F
C
A
B
Not Used
Not Used
771 PRND A
772 PRND B
773 PRND C
776 PRND PARITY
470 SENSOR GROUND
275 PARK SELECT
2840 B+
24 BACK UP LAMPS
Power Inverter Module
High
Low
High
Low
PCM
BPM, LHJB, and RHJB
RHJB
Back Up Lamps

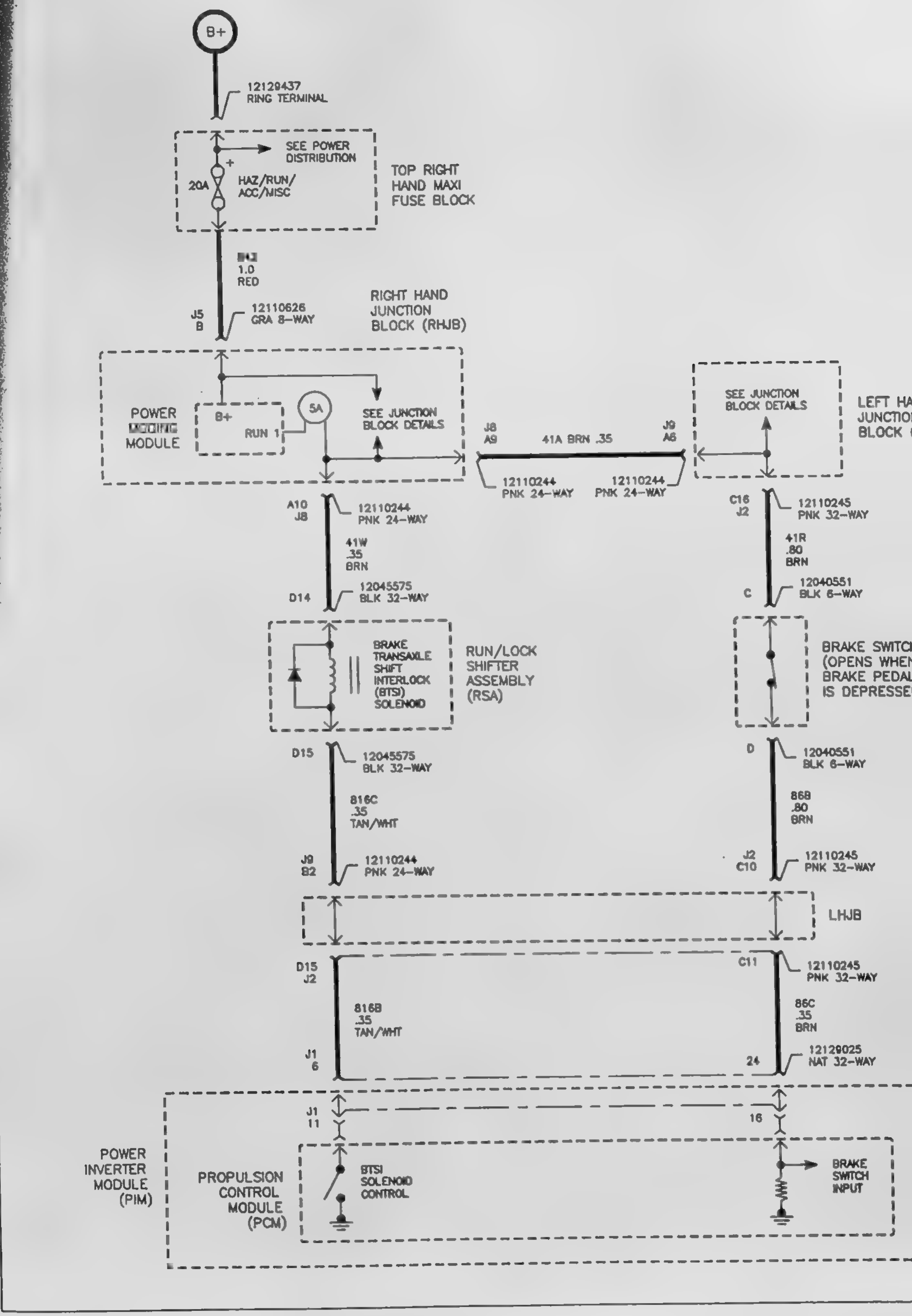


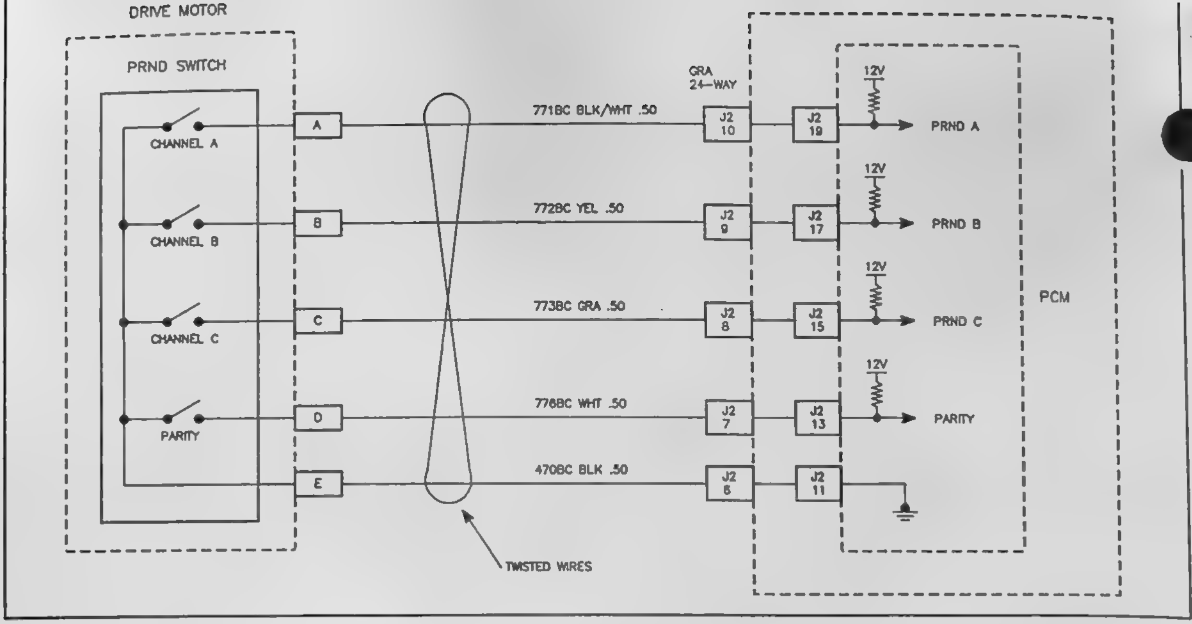
PRND INPUTS

The PRND inputs are used by the propulsion control module (PCM) to determine vehicle direction or state. The battery pack module (BPM) uses the park input to enable charging. The PCM will also lock the BTSI when the vehi is in park while charging.

PARK PAWL

The park pawl lever is moved by a cable interface between the shift lever and the PRND switch. As the lever is moved into park the pawl is rotated into the lock position preventing the vehicle from moving.


B+
12129437
RING TERMINAL
SEE POWER DISTRIBUTION
20A
HAZ/RUN/ACC/MISC
TOP RIGHT HAND MAXI FUSE BLOCK
1.0
RED
J5
B
12110626
GRA 8-WAY
RIGHT HAND JUNCTION BLOCK (RHJB)
POWER
MODULE
B+
RUN 1
5A
SEE JUNCTION BLOCK DETAILS
J8
A9
41A BRN .35
J9
A6
12110244
PNK 24-WAY
12110244
PNK 24-WAY
SEE JUNCTION BLOCK DETAILS
LEFT HA
JUNCTIO
BLOCK (
A10
J8
12110244
PNK 24-WAY
41W
.35
BRN
D14
12045575
BLK 32-WAY
BRAKE TRANSAXLE SHIFT INTERLOCK (BTSI) SOLENOID
RUN/LOCK SHIFTER ASSEMBLY (RSA)
C16
J2
12110245
PNK 32-WAY
41R
.80
BRN
C
12040551
BLK 6-WAY
BRAKE SWITC
(OPENS WHEN
BRAKE PEDAL
IS DEPRESSE
D15
12045575
BLK 32-WAY
816C
.35
TAN/WHT
J9
B2
12110244
PNK 24-WAY
D
12040551
BLK 6-WAY
868
.80
BRN
J2
C10
12110245
PNK 32-WAY
LHJB
D15
J2
816B
.35
TAN/WHT
J1
6
C11
12110245
PNK 32-WAY
86C
.35
BRN
24
12129025
NAT 32-WAY
J1
11
16
POWER INVERTER MODULE (PIM)
PROPULSION CONTROL MODULE (PCM)
BTSI SOLENOID CONTROL
BRAKE SWITCH INPUT



PSMELC67668AA

INVALID PRND REQUEST DETECTED

The propulsion control module (PCM) reads the PRND position from an encoder which provides three signals plus a parity bit. Using this parity bit, the PCM can detect a failure of any single switch.

DTC PARAMETERS

The DTC will set when the PRND input does not match one of the following valid combinations for a period of 60 seconds.

ACTION TAKEN BY THE PCM

The DSCM will light all four PRND indicators when an invalid PRND position has been present for 60 seconds. The PCM will retain the last valid PRND mode for a period of 250 milliseconds, and then will assume neutral. If a valid PRND input is then detected, normal operation resumes after shifting to Neutral or Park and back to Drive. If this occurs the SERVICE SOON telltale is turned Off after 10 seconds.

RELATED DTCS

BPM 285

TELLTALE ILLUMINATED:

SERVICE SOON

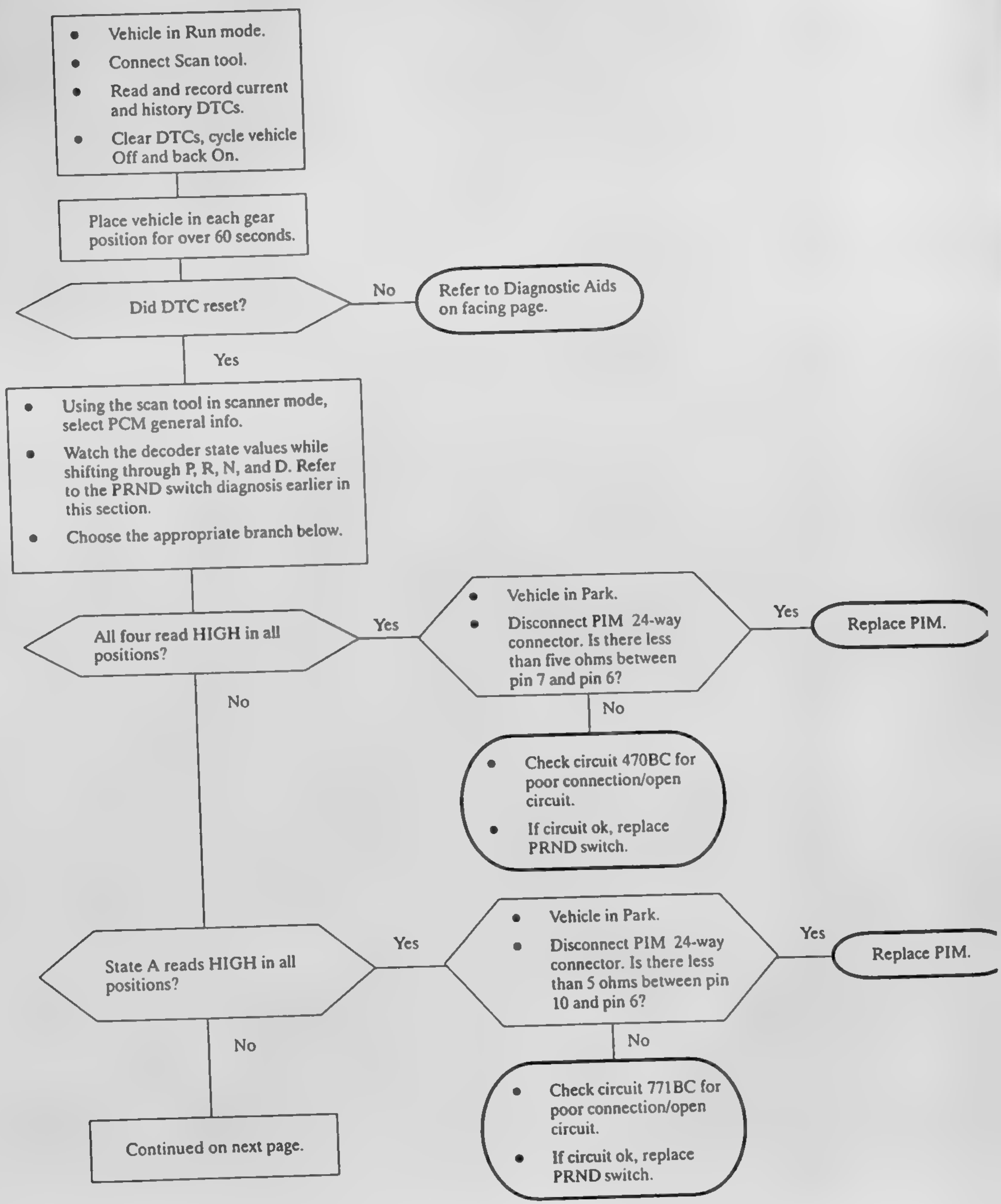
DIAGNOSTIC AIDS

- This can be caused by misalignment of the PRND cable, a failure of the PRND encoder, a short in the PRND wiring, or failure of the PCM input circuitry.
- If the shifter is held for one minute in an in between gear position this DTC will set. This a NORMAL CONDITION.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

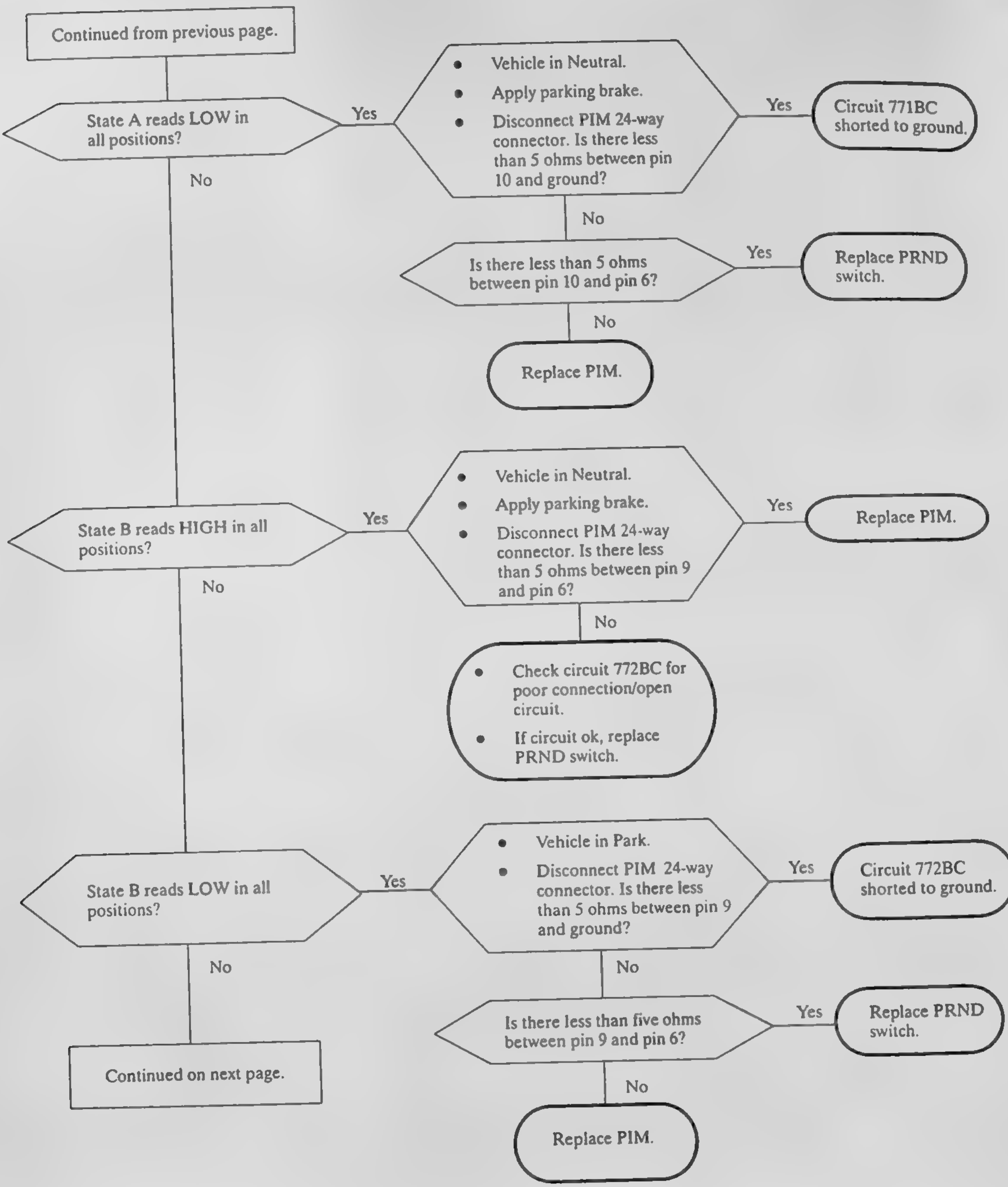
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

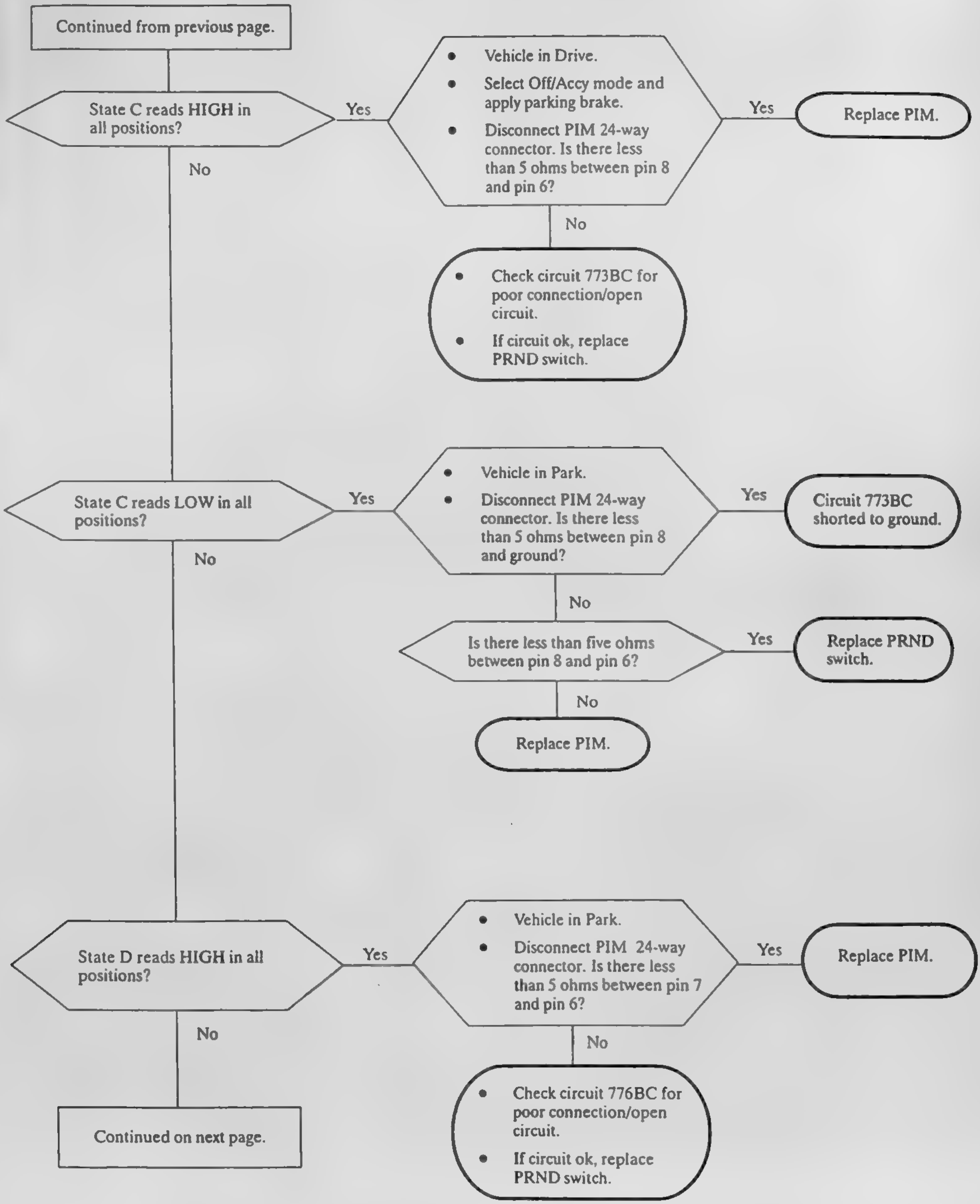
PCM DTC 61
INVALID PRND REQUEST DETECTED

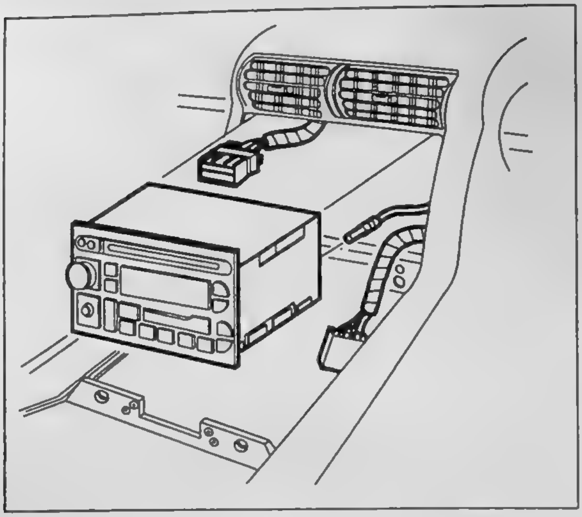


PCM DTC 61
INVALID PRND REQUEST DETECTED – CONTINUED



PCM DTC 61
INVALID PRND REQUEST DETECTED – CONTINUED

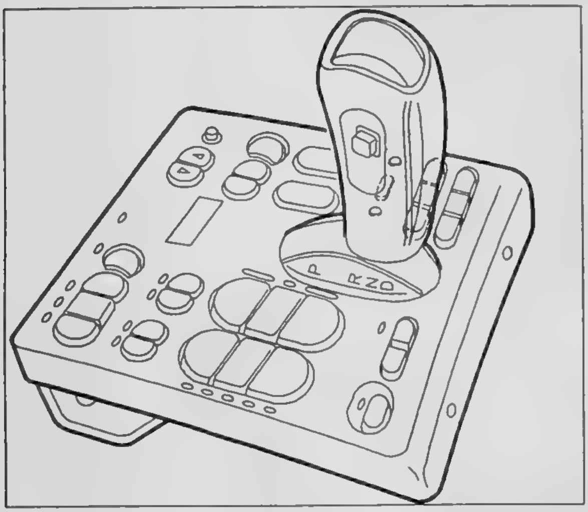




PSMELC65847AA

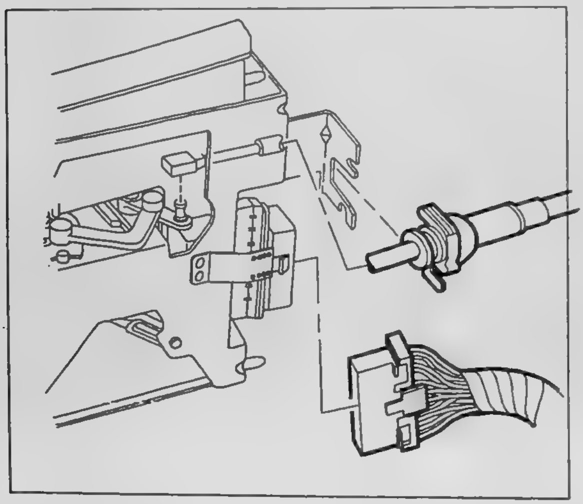
8. Disconnect the antenna lead first, then the harnes connector.

9. With the brake applied, select the RUN mode again, and shift back to PARK. Then select the lock mode to turn the vehicle Off.



PSMELC66357AA

10. Remove the T-25 TORX™ screws in the rear of the RSA, pull RSA rearward about 63 mm (2.5 in.).



PSMELC66358AA

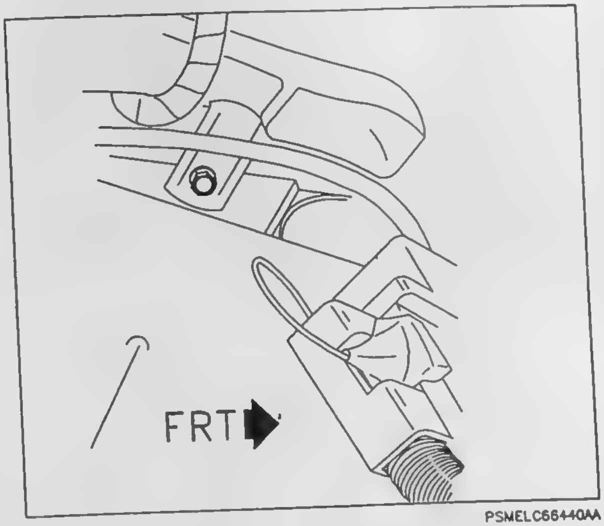
11. Rotate RSA toward the drivers side of the vehicle to a 45 degree angle.

12. Disconnect the RSA wire harness connector.

13. Disconnect the shift cable from the shifter and remove shift cable from retainer bracket by prying locking tab on drivers side of RSA gently and pushing cable down out of bracket.

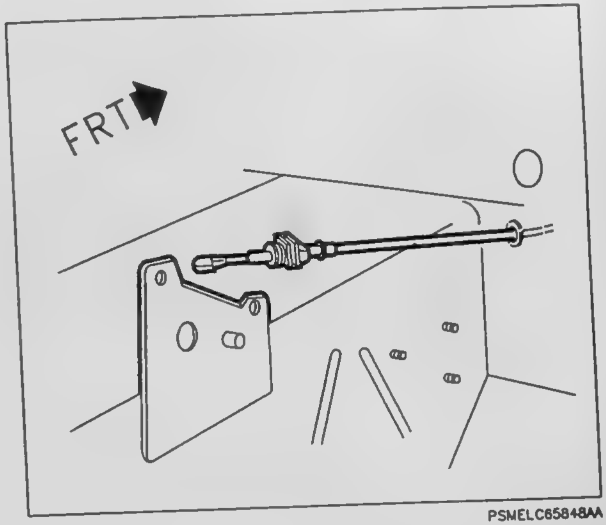
Pull down carpet and remove T-25 TORX™ torx bolt from passenger side floor duct.

Remove passenger side floor duct.



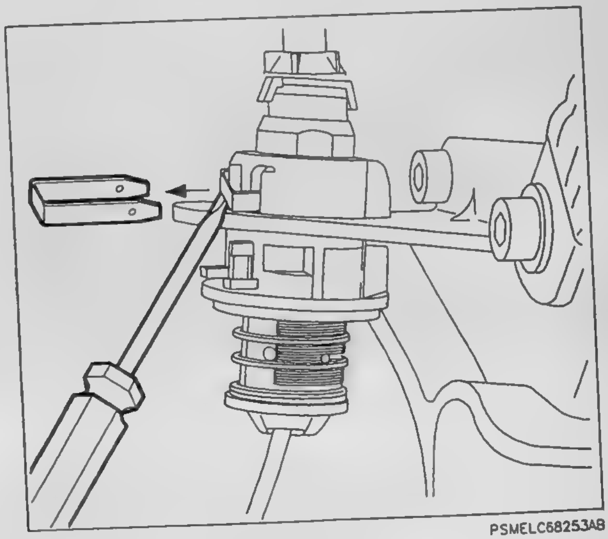
PSMELC66440AA

16. Remove RSA cable from console area and through front of dash.
17. Remove underbody front air deflector. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



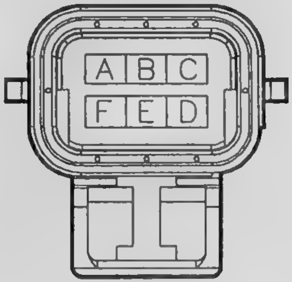
PSMELC65848AA

18. Remove clip from cable.



PSMELC68253AB

PARK REVERSE NEUTRAL DRIVE (PRND) SWITCH #1



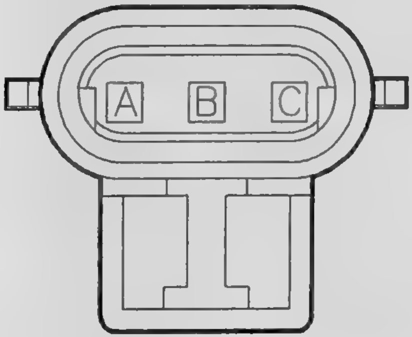
PSMELC67215AA

BLACK
12052848

PRND SWITCH #1 – 12052848				
CAVITY	WIRE COLOR	CIRCUIT NO.	WIRE-SIZE	CIRCUIT FUNCTION
A	BLK/WHT	771BC	.50	CHANNEL A
B	YEL	772BC	.50	CHANNEL B
C	GRA	773BC	.50	CHANNEL C
D	WHT	776BC	.50	PARITY
E	BLK	470BC	.50	GROUND
F				

Location: Underhood, Front Center of Drive Motor

PARK REVERSE NEUTRAL DRIVE (PRND) SWITCH #2



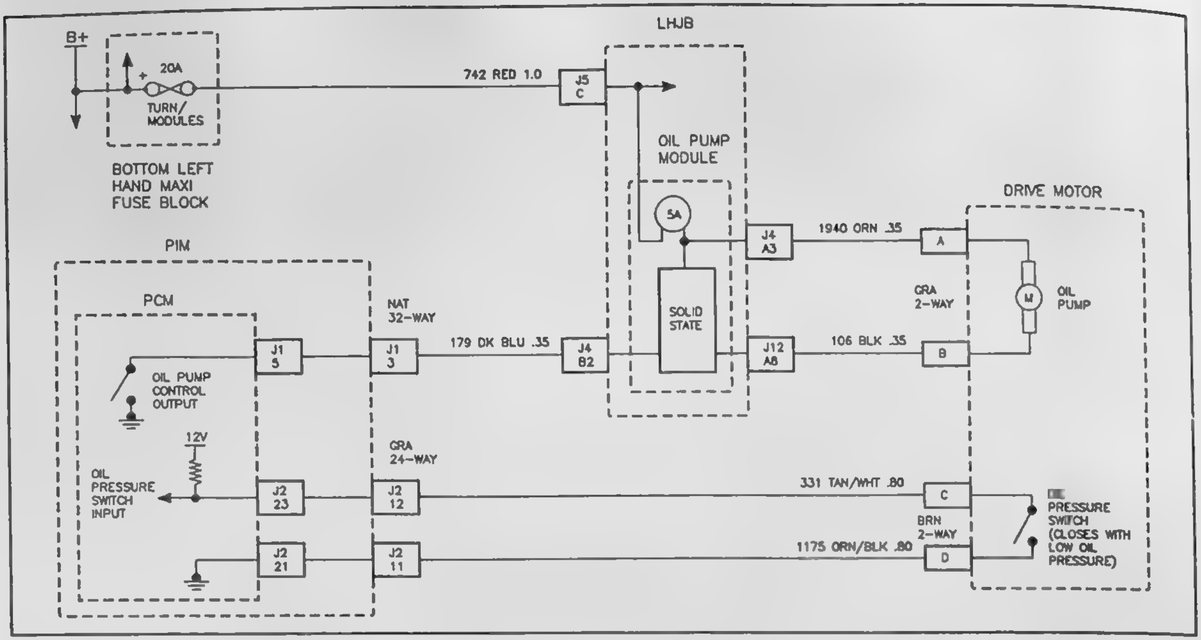
BLACK

PSMELC67197AA

PRND SWITCH #2 – 12110293				
CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
A	ORN	2840	.80	B+
B	LT GRN	24A	.50	REVERSE SELECT
C	LT GRN	275E	.35	PARK SELECT

Location: Underhood, Lower Center of Drive Motor

DTC 032 – OIL PRESSURE FAULT (NO PRESSURE)



PSMELC67659AB

OIL PRESSURE FAULT (NO PRESSURE)

The propulsion control module (PCM) controls the drive motor oil pump via a relay, and receives feedback from an oil pressure sensor (On/Off switch). The oil pump is turned On briefly after powerup and whenever the vehicle is moving.

DTC PARAMETERS

The DTC will set any time the PCM detects the oil pressure switch closed for 15 seconds.

ACTION TAKEN BY THE PCM

The SERVICE NOW and REDUCED PERFORMANCE telltales are illuminated, the DTC is set and reduced performance mode is entered. If the fault is intermittent and clears itself, the telltale will turn Off after 10 seconds and the PCM will return to normal operation.

RELATED DTCS

None

TELLTALE ILLUMINATED:

SERVICE NOW AND
REDUCED PERFORMANCE

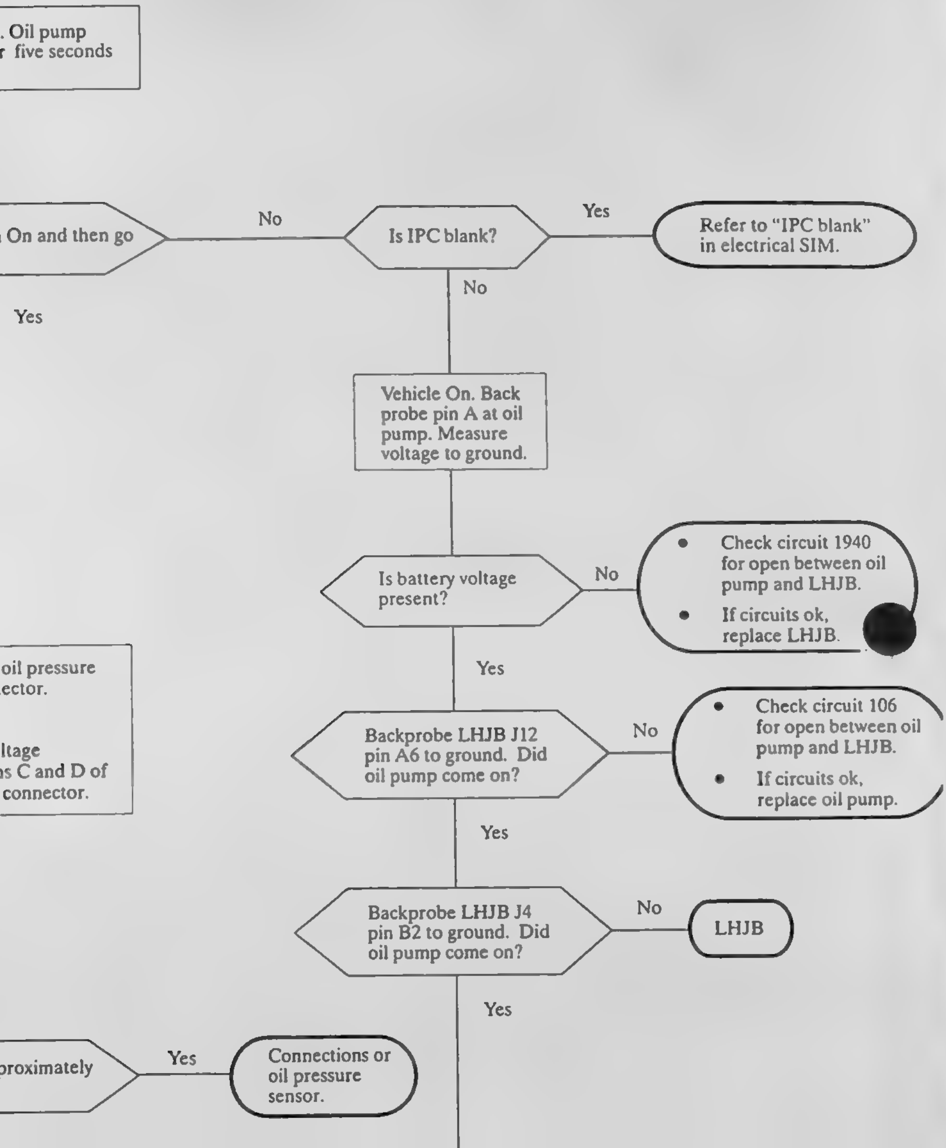
DIAGNOSTIC AIDS

- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

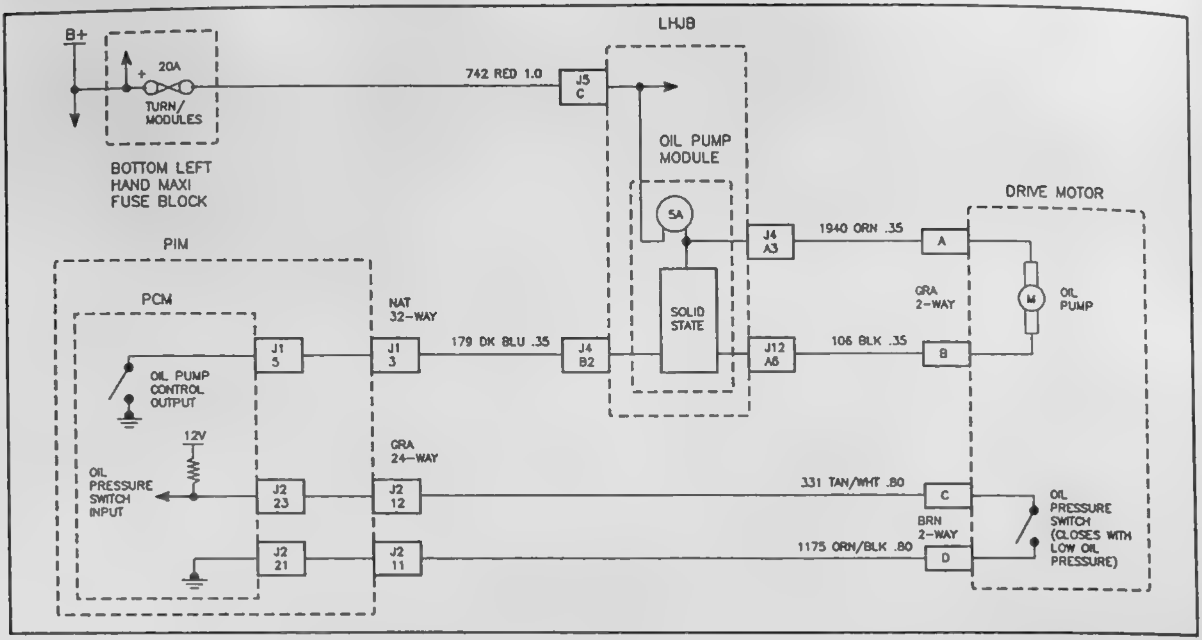
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

DTC 032
OIL PRESSURE FAULT (NO PRESSURE)



DTC 033 – OIL PRESSURE FAULT (PRESSURE WHEN PCM HAS COMMANDED PUMP OFF)



PSMELC67659AB

OIL PRESSURE FAULT (PRESSURE WHEN PCM HAS COMMANDED PUMP OFF)

The propulsion control module (PCM) controls the drive unit oil pump via the junction block, and receives feedback from an oil pressure sensor (On/Off switch). The oil pump is turned On briefly after powerup and whenever the vehicle is moving.

DTC PARAMETERS

The DTC will set any time the PCM has commanded the oil pump Off, and senses oil pressure at the switch for 15 seconds.

ACTION TAKEN BY THE PCM

The SERVICE SOON telltale will be illuminated and the DTC will be stored. If the fault is intermittent and clears itself, the telltale will turn off after 10 seconds.

RELATED DTCS

None

TELLTALE ILLUMINATED:

SERVICE SOON

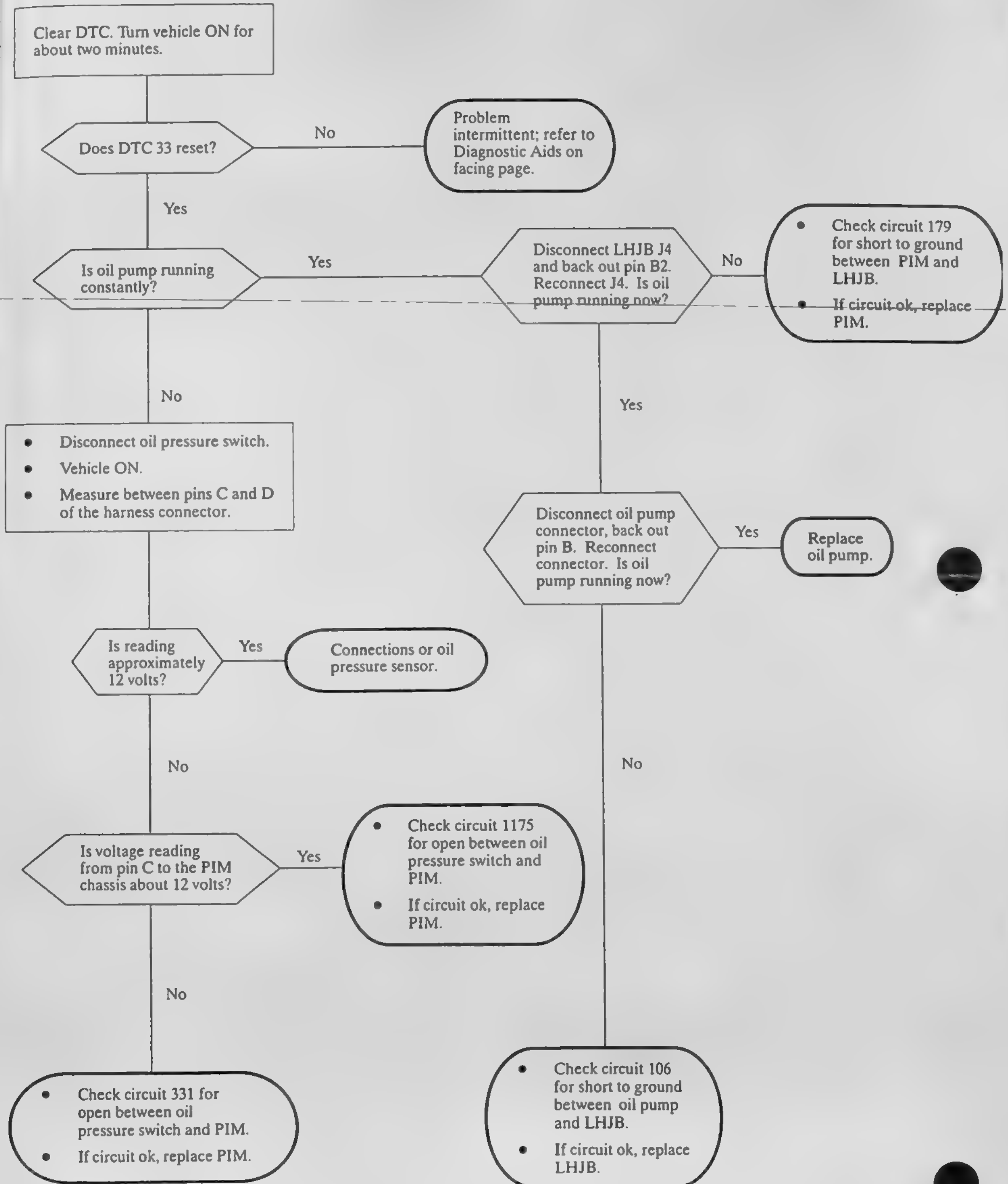
DIAGNOSTIC AIDS

- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

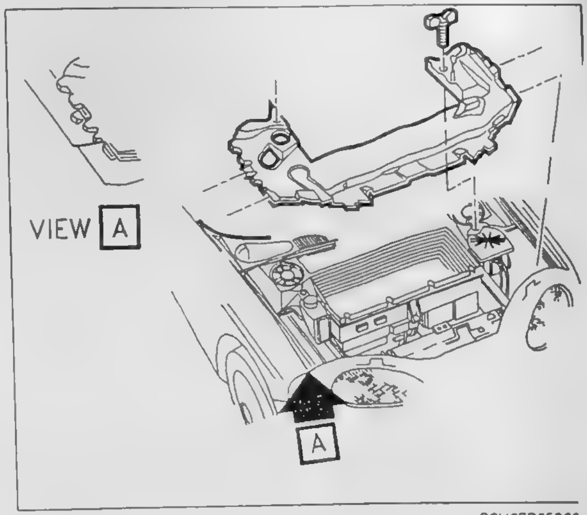
- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the

DTC 033
OIL PRESSURE FAULT (PRESSURE WHEN PCM HAS COMMANDED O



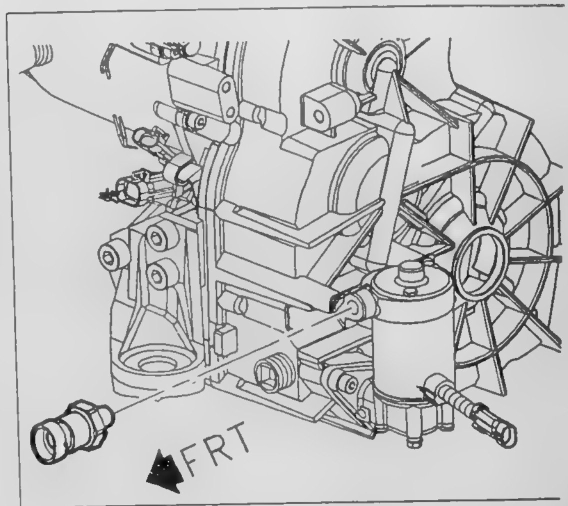
OIL PRESSURE SWITCH

1. Remove engine compartment sight shield.



PSMCEP65869

2. Disconnect the oil pressure switch connection from oil pressure switch.
3. Using a special tool EV9732E remove oil pressure switch.



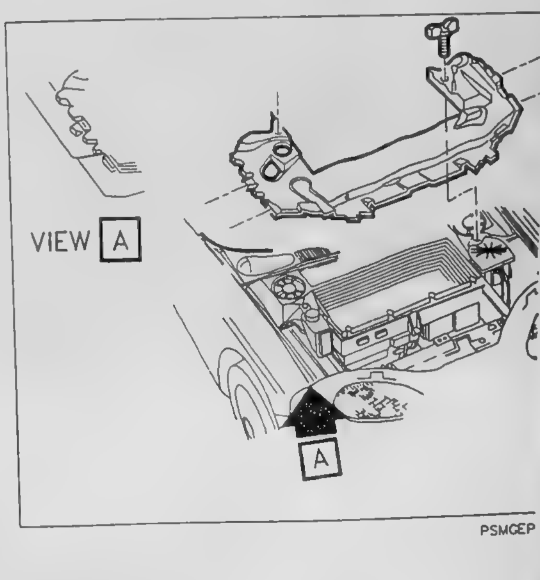
PSMPEN66:

INSTALLATION

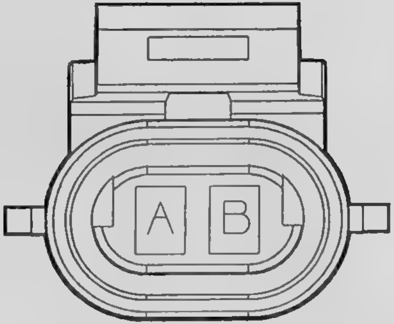
1. Hand start the oil pressure switch.
2. Using a special tool EV9732E tighten the oil pressure switch.

Torque: **23 N•m (17 ft−lbs)**

3. Reconnect oil pressure switch connector.
4. Install the engine compartment sight shield.



PSMCEP



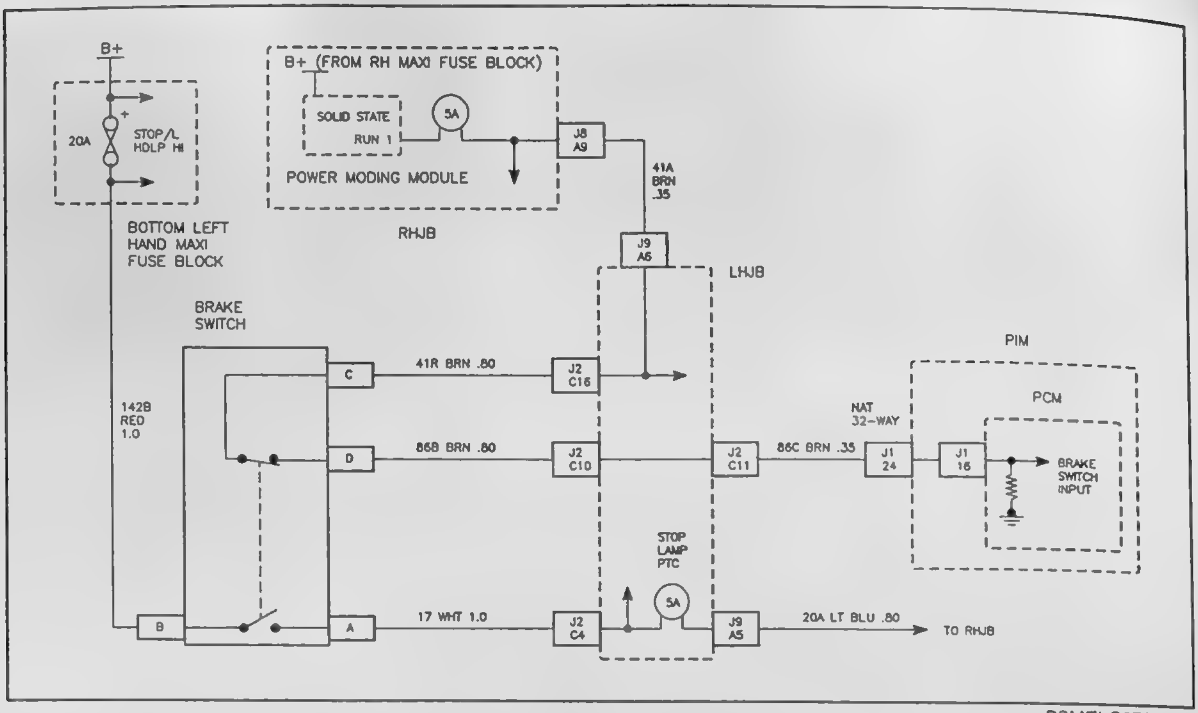
GRAY
12052644

PSMELC66031AA

OIL PUMP – 12052644				
CAVITY	WIRE COLOR	CIRCUIT NO.	WIRE-SIZE	CIRCUIT FUNCTION
A	ORN	1940	.35	B+
B	BLK	106	.35	PUMP LO

Location: Underhood, Left Side of Drive Motor

DTC 077 – SERVICE BRAKE SWITCH INVALID AT POWER DOWN



PSMELC67667AA

SERVICE BRAKE SWITCH INVALID AT POWER DOWN

The propulsion control module (PCM) reads the service brake switch so that it can be disable cruise control when the brake is pressed. This switch is powered off of switched 12 V so that they are forced low when IGN 1 is low. The PCM checks the state of these switches at power down in order to ensure that they are all low after IGN 1 has gone low.

DTC PARAMETERS

The DTC will set when the service brake switch is over 3.5 V after RUN 1 has gone below 2.5 V at power down.

ACTION TAKEN BY THE PCM

Cruise control is disabled on next ignition cycle. This fault is latched through the next ignition cycle until the test is performed again at power down. If the service brake switch power down test is later passed, cruise control will be enabled on the next ignition cycle.

RELATED DTCS

None

TELLTALE ILLUMINATED:

None

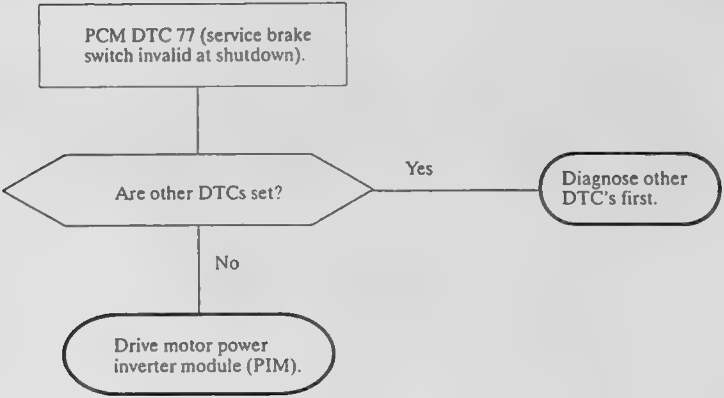
DIAGNOSTIC AIDS

- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

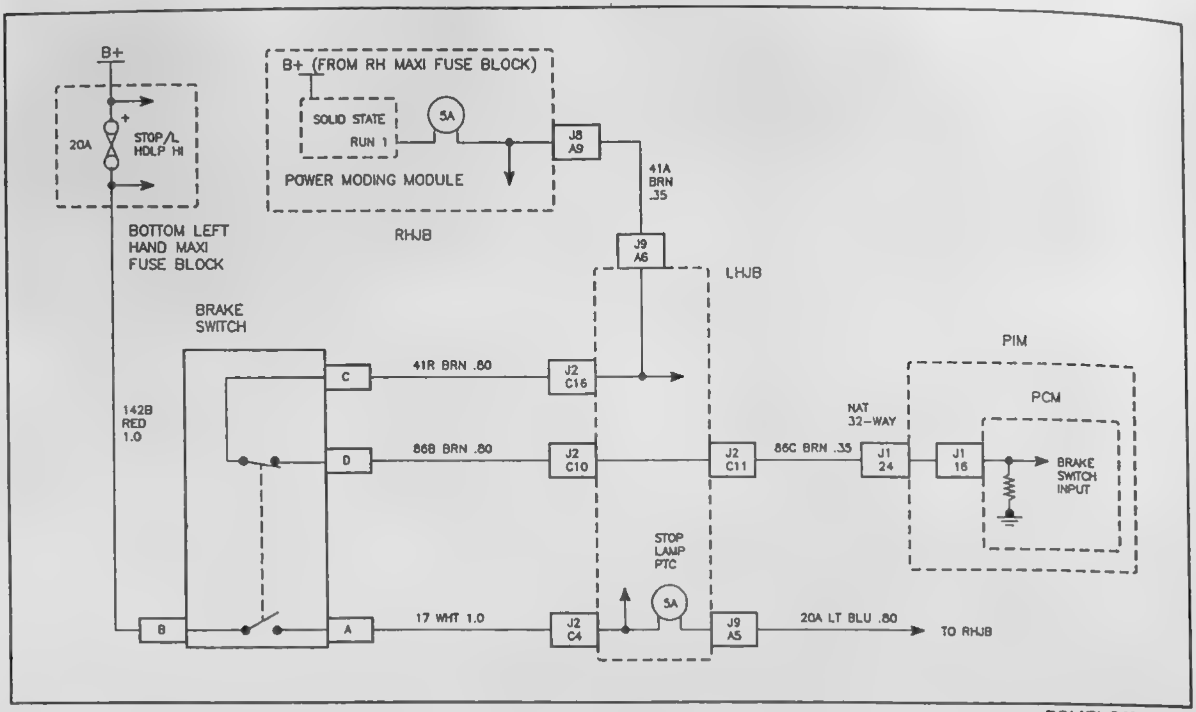
* Select Malfunction History from the Scan tool PCM menu.

- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

DTC 077
SERVICE BRAKE SWITCH INVALID AT POWER DOWN



DTC 095 – BRAKE SWITCH STUCK OPEN



PSMELC67667AA

BRAKE SWITCH STUCK OPEN

The propulsion control module (PCM) reads its discrete brake switch input and also receives from the BTCM via serial data brake switch input.

DTC PARAMETERS

This DTC will set anytime the retard request input is greater than 18 percent and PCM brake switch input reads switch On (brake applied) but BTCM's input reads switch On (brake released) continuously for five seconds.

ACTION TAKEN BY THE PCM

The DTC will be set, Regen and cruise control disabled. The fault will latch the remainder of the power ON cycle and will clear on next power-up if fault is not present.

RELATED DTCS

BTCM 91, 94, and 95

TELLTALE ILLUMINATED:

SERVICE SOON

DIAGNOSTIC AIDS

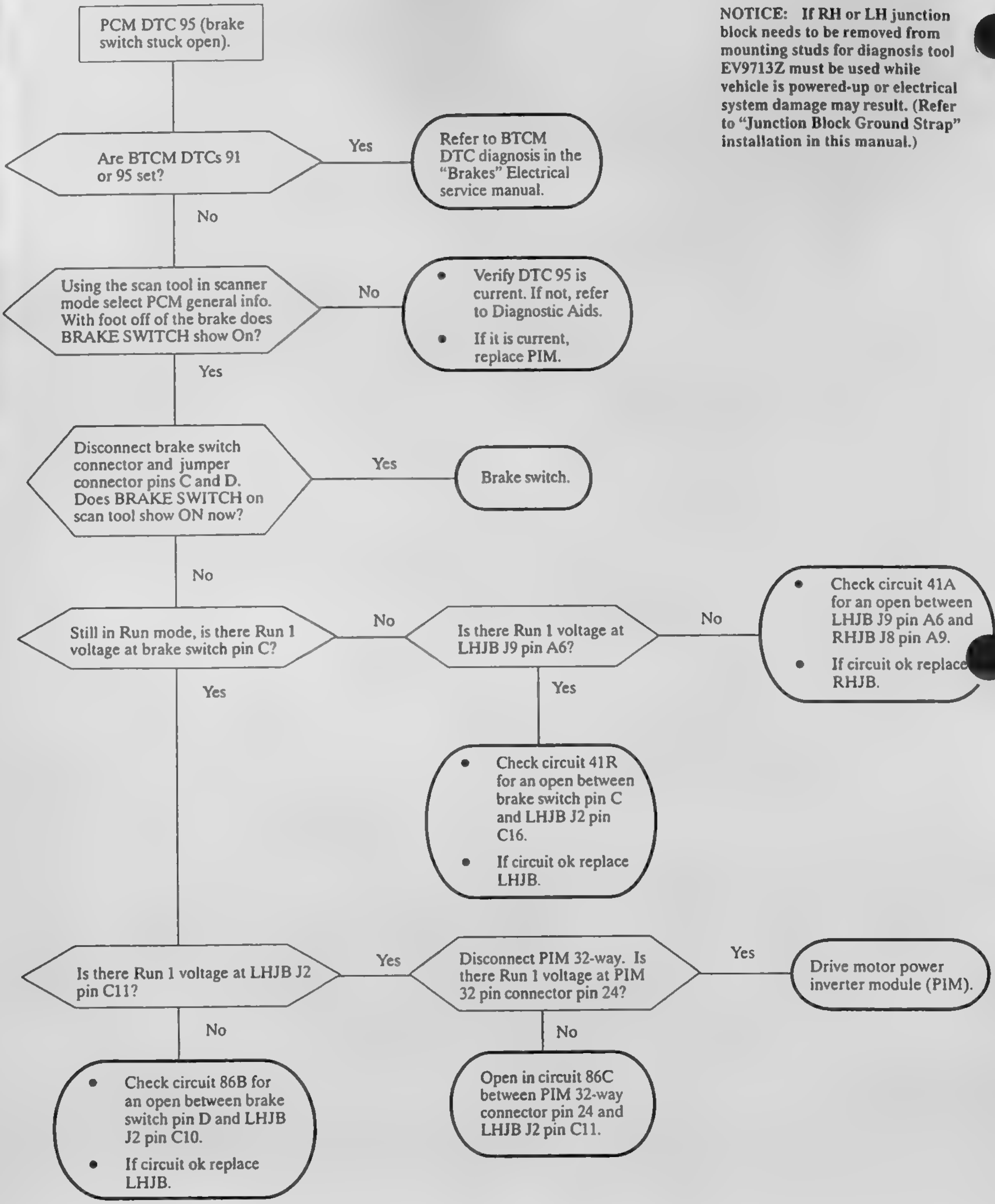
- If DTC is intermittent find out from the customer when the light comes on? Try cycling the brake switch multiple times while watching the brake switch input on the scan tool to see if it ever sticks. Try driving over bumps and around corners to duplicate. If the condition can be duplicated try following trouble tree while condition is present.
- When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

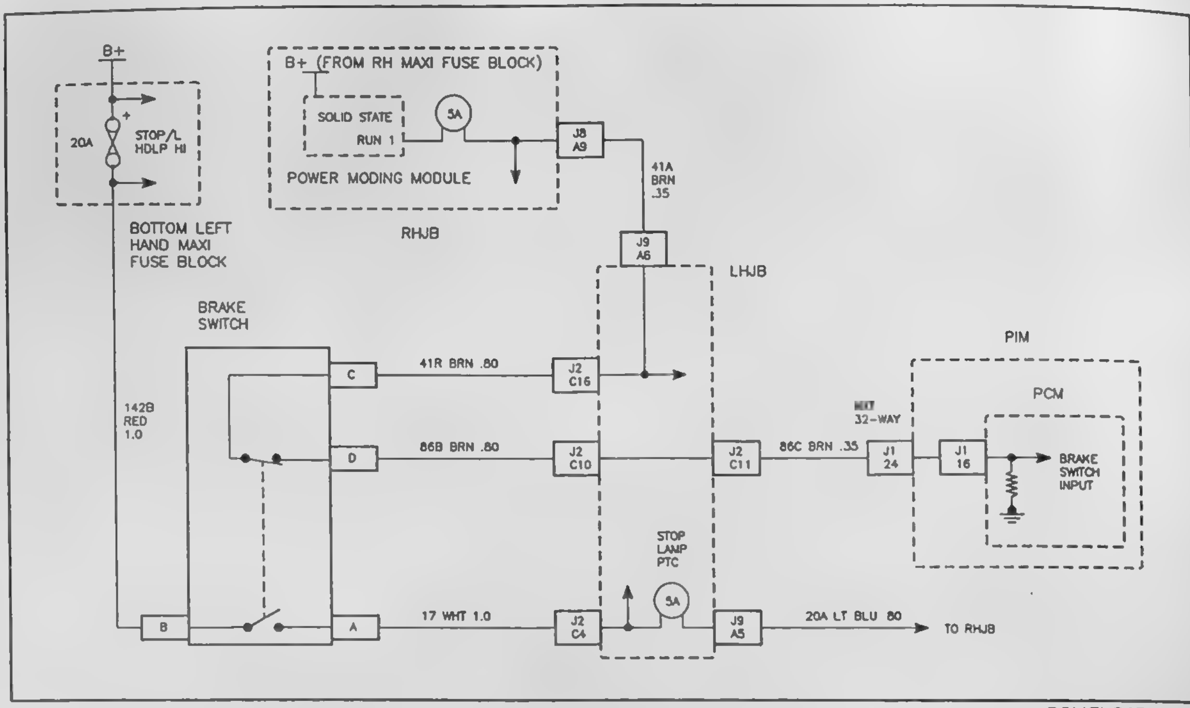
- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire

DTC 095
BRAKE SWITCH STUCK OPEN

NOTICE: If RH or LH junction block needs to be removed from mounting studs for diagnosis tool EV9713Z must be used while vehicle is powered-up or electrical system damage may result. (Refer to "Junction Block Ground Strap" installation in this manual.)



DTC 096 – BRAKE SWITCH STUCK CLOSED



PSMELC67667AA

BRAKE SWITCH STUCK CLOSED

The propulsion control module (PCM) reads its discrete brake switch input and also receives from the BTCM via serial data brake switch input.

DTC PARAMETERS

This DTC will set anytime the PCM sees the brake switch Off (brake released) but BTCM indicates brake switch Off (brake applied) after the vehicle is stopped three times from 0–32 km/h (0 to 20 mph) speed range OR if vehicle speed is greater than 81 km/h (50 mph) for more than 30 seconds.

ACTION TAKEN BY THE PCM

The DTC will be set, Regen and cruise control disabled. The fault will latch the remainder of the power ON cycle and will clear on next power-up if fault is not present.

RELATED DTCS

BTCM 94

TELLTALE ILLUMINATED:

SERVICE SOON

DIAGNOSTIC AIDS

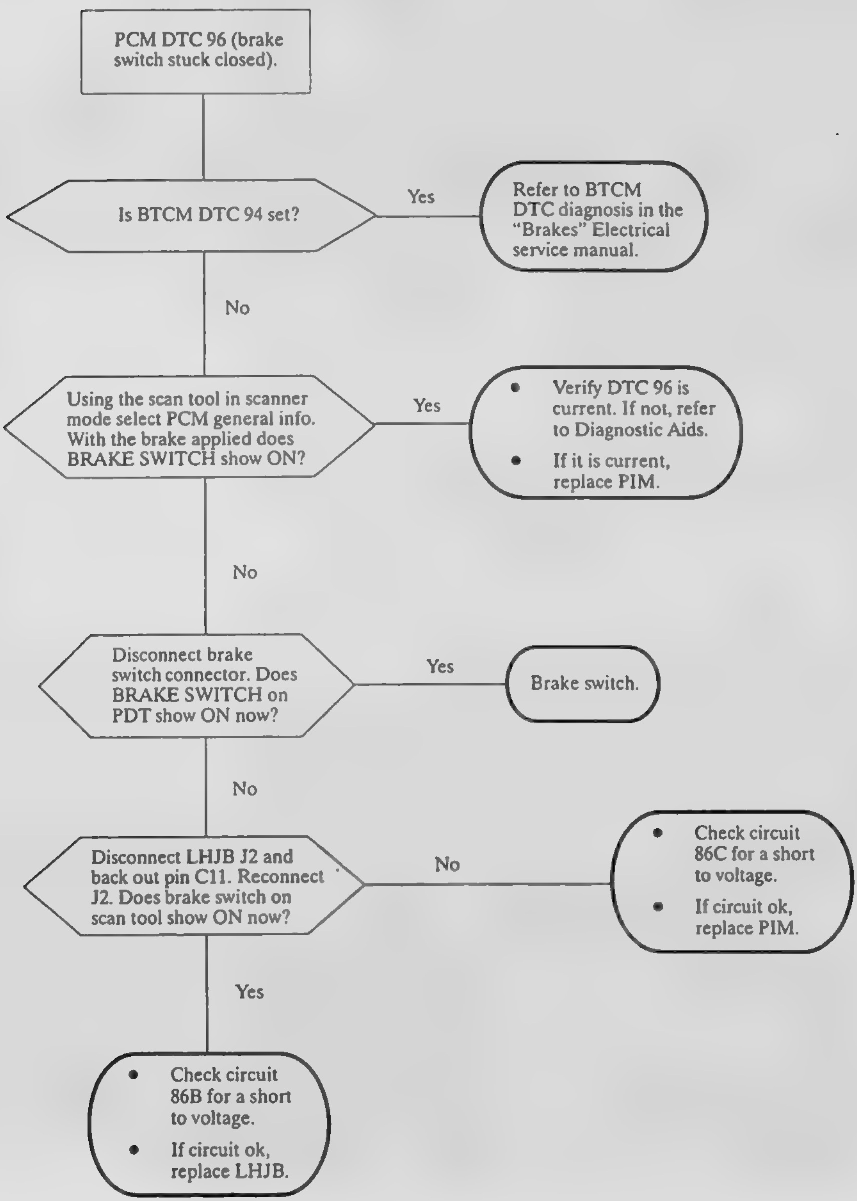
- If DTC is intermittent find out from the customer when the light comes on. Try cycling the brake switch multiple times while watching the brake switch input on the PDT to see if it ever sticks. Try driving over bumps and around corners to duplicate. If the condition can be duplicated try following trouble tree while condition is present.
- This DTC may be set by a steady partial brake apply while driving. There are two switch contacts in the brake switch and if they don't transition within 30 seconds of each other, this DTC is set.

When attempting to diagnose an intermittent problem, use the Scan tool* and review malfunction history diagnostic information. This data can be used to determine the conditions that were present when the DTC set.

* Select Malfunction History from the Scan tool PCM menu.

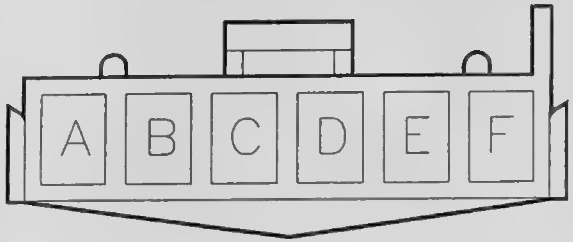
- Check the tightness of the female terminal grip with a spare male terminal.
- If the problem is intermittent wiggle the wire harness while viewing the Scan tool and see if the value changes or the DTC sets.

DTC 096
BRAKE SWITCH STUCK CLOSED



HARNESS CONNECTOR FACES

STOPLAMP SWITCH



BLACK
12040551

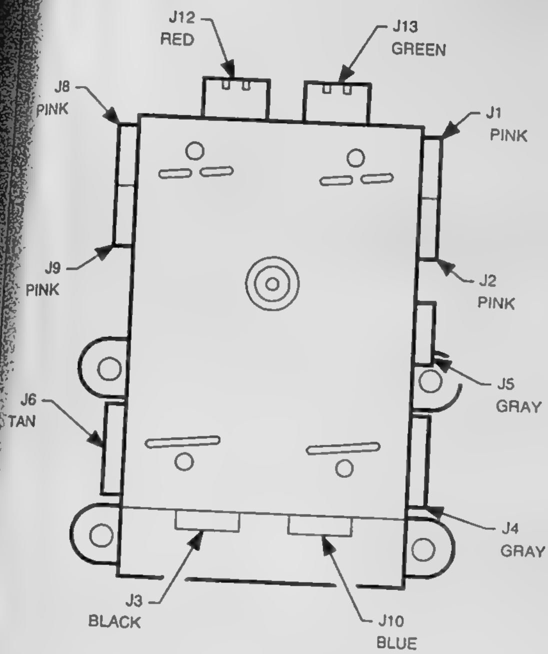
PSMELC67258AA

STOPLAMP SWITCH – 12040551				
CAVITY	WIRE COLOR	CIRCUIT NUMBER	WIRE SIZE	CIRCUIT FUNCTION
A	WHT	17	1.0	B+ OUT TO STOP LAMPS
B	RED	142B	1.0	B+
C	BRN	41R	.80	RUN 1
D	BRN	86B	.80	BRAKE SWITCH OUT TO PCM
E				
F				

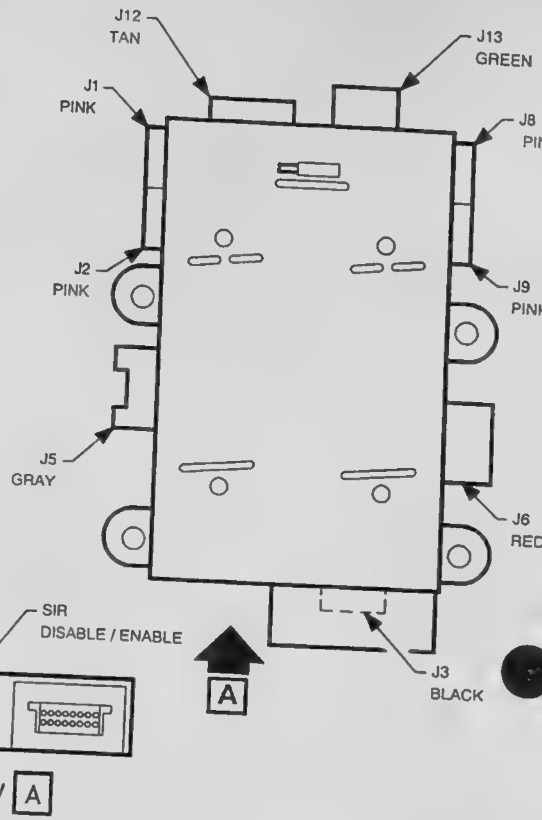
Location: Passenger Compartment, Under Left Side of I/P – Near Brake Pedal

JUNCTION BLOCK CONNECTOR LOCATIONS

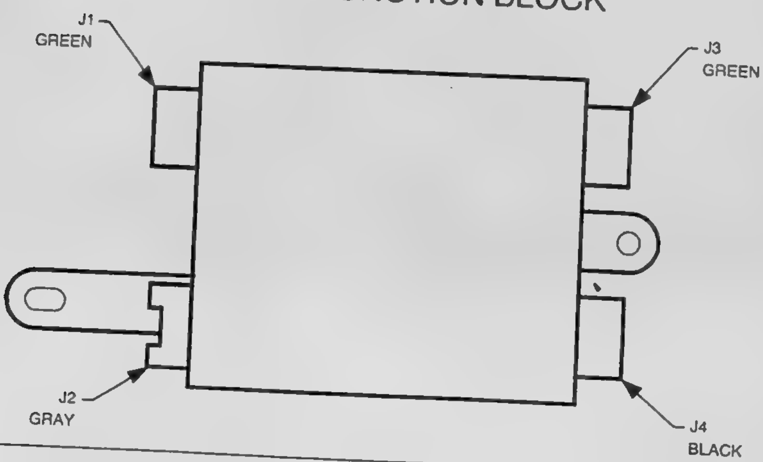
LH JUNCTION BLOCK



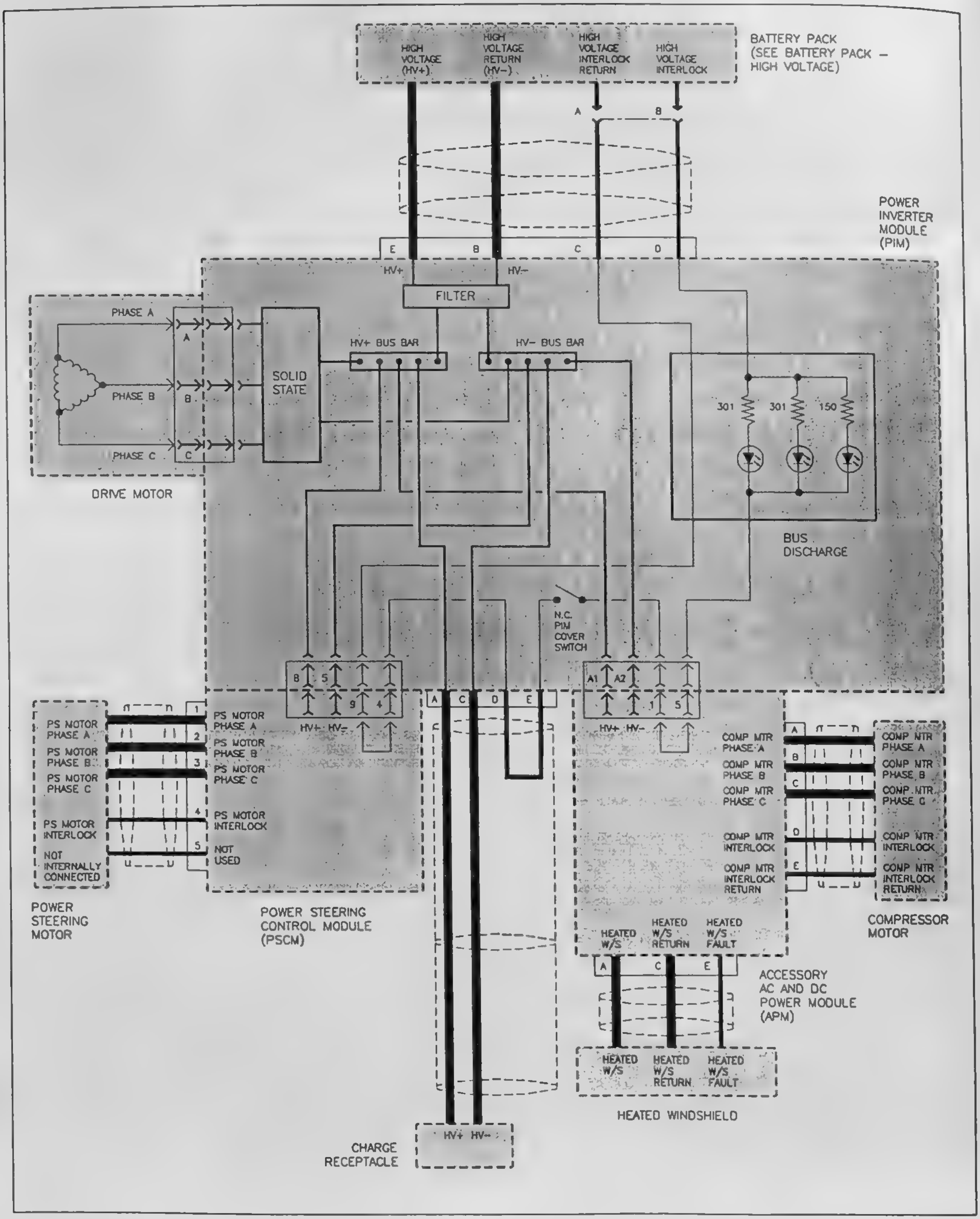
RH JUNCTION BLOCK



TRUNK JUNCTION BLOCK

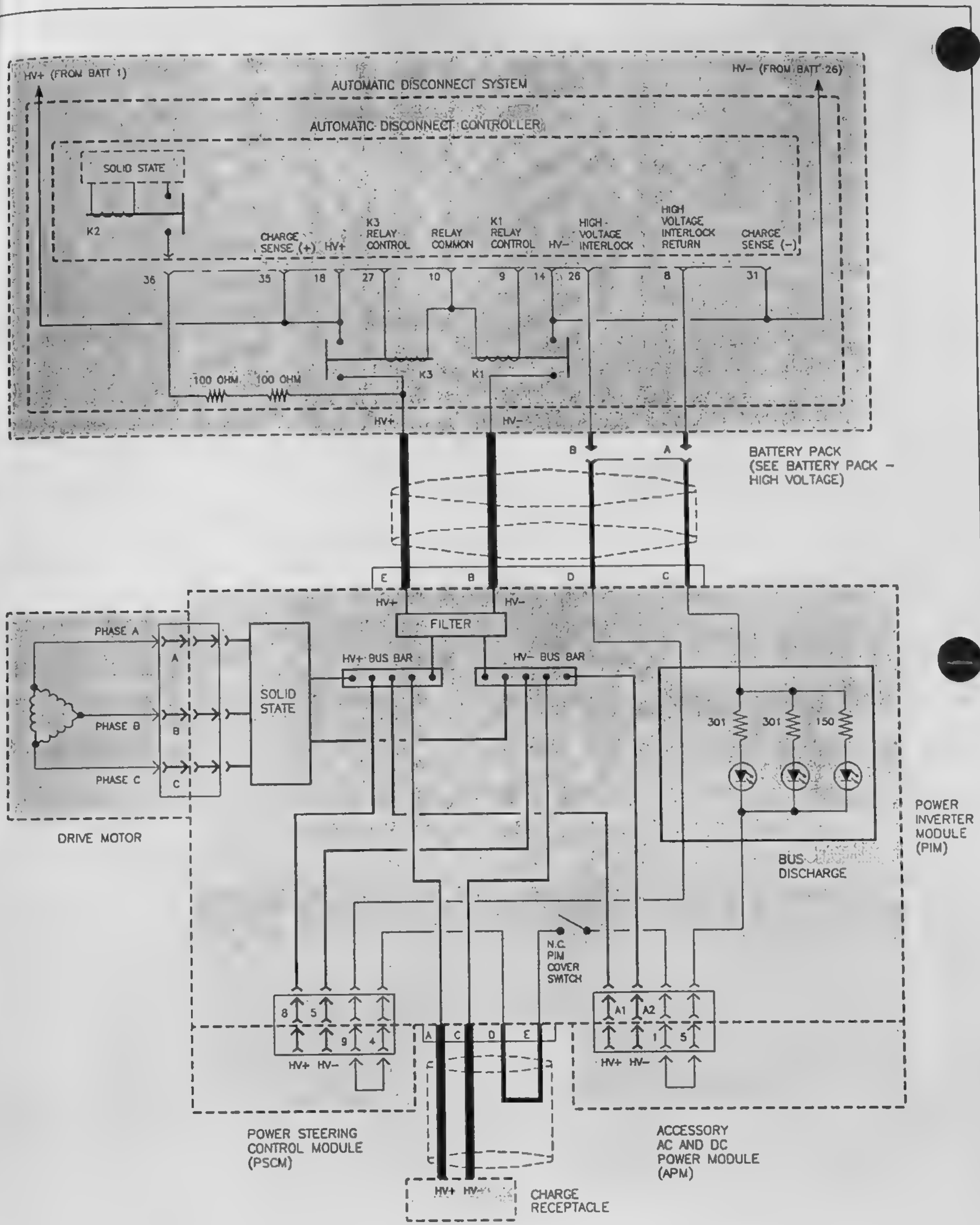


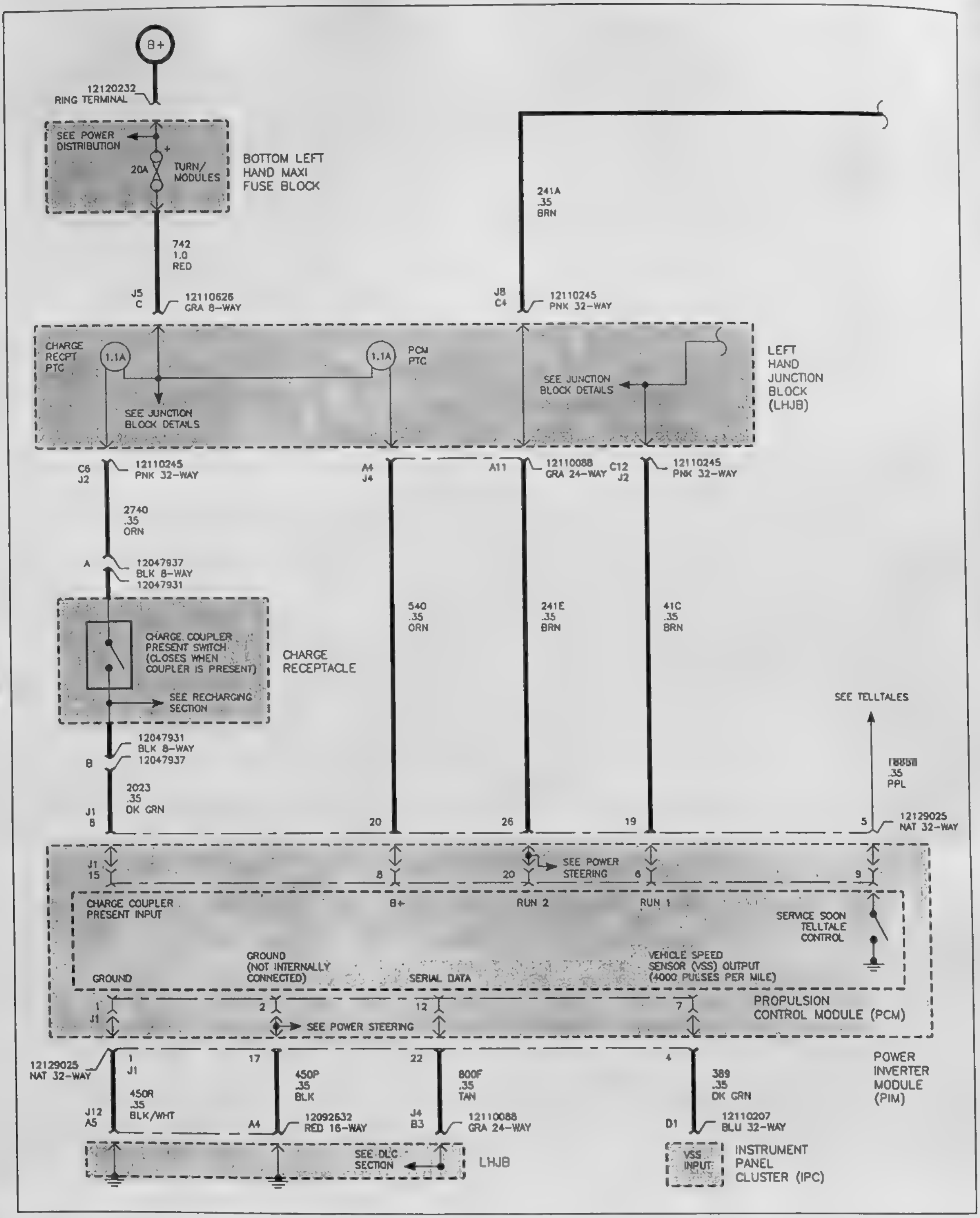
PROPULSION (HIGH VOLTAGE)



PSMELC67642AC

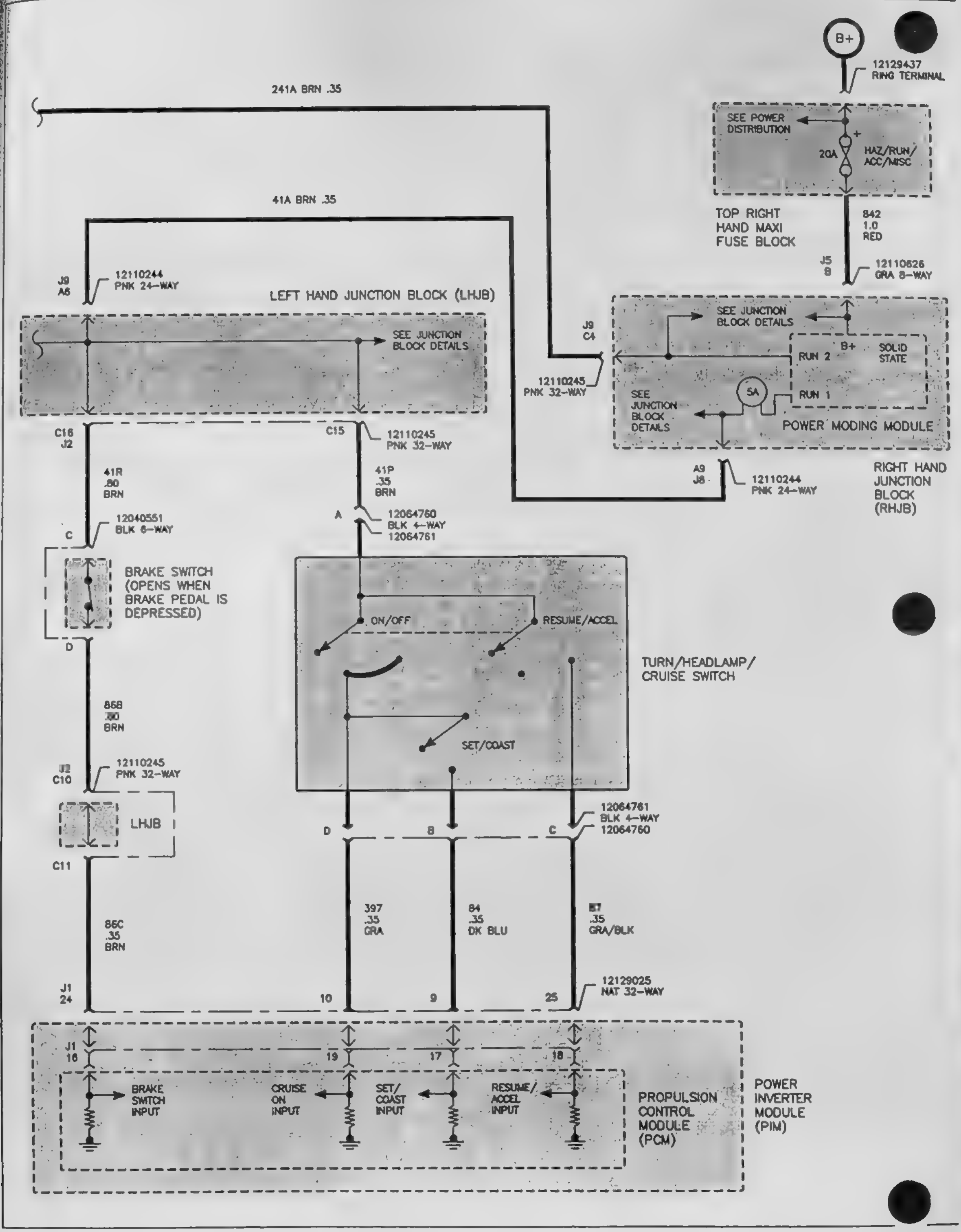
PROPULSION (HIGH VOLTAGE–CONT.)



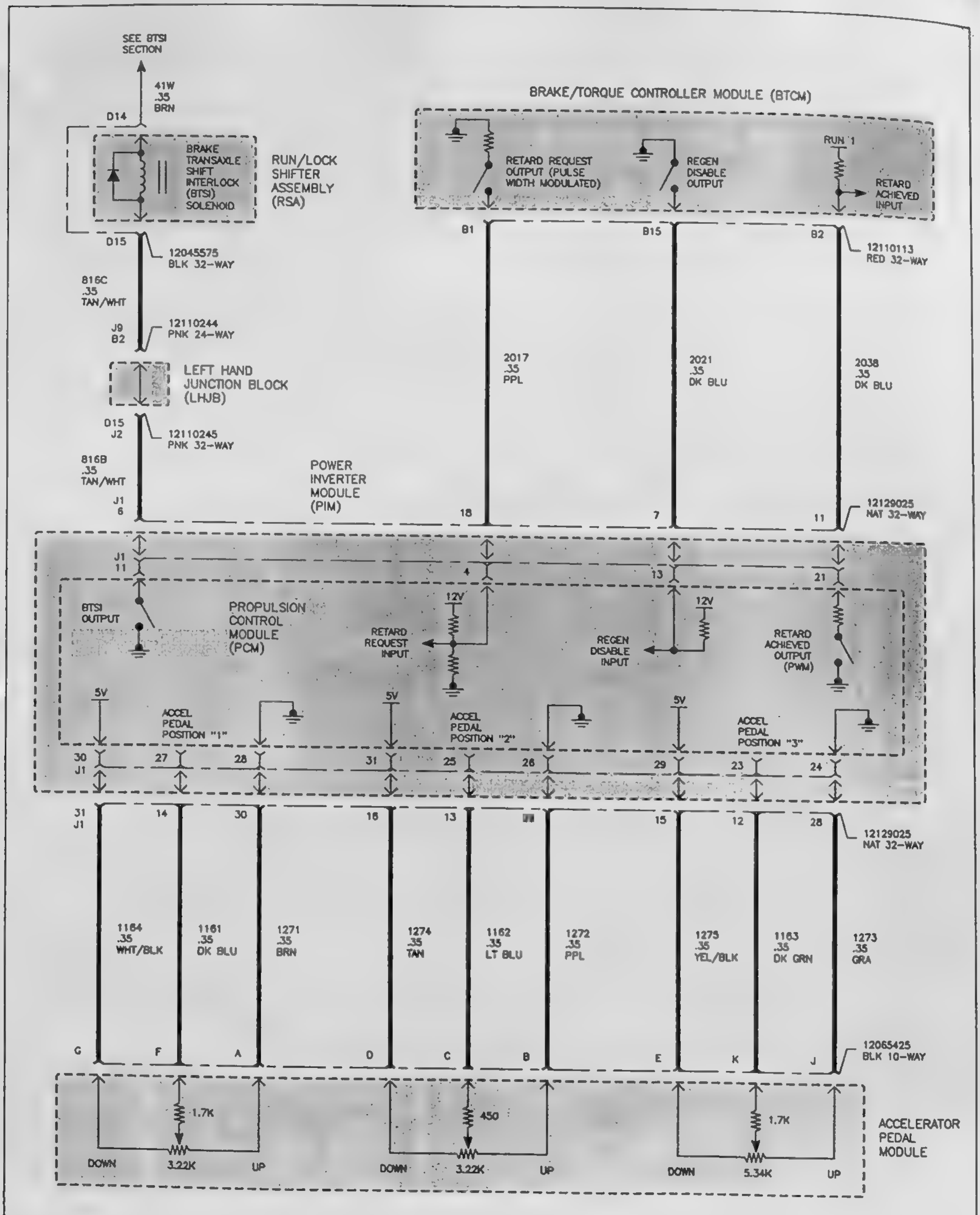


PSMELC67644AB

PROPULSION (LOW VOLTAGE–CONT.)



PSMELC676



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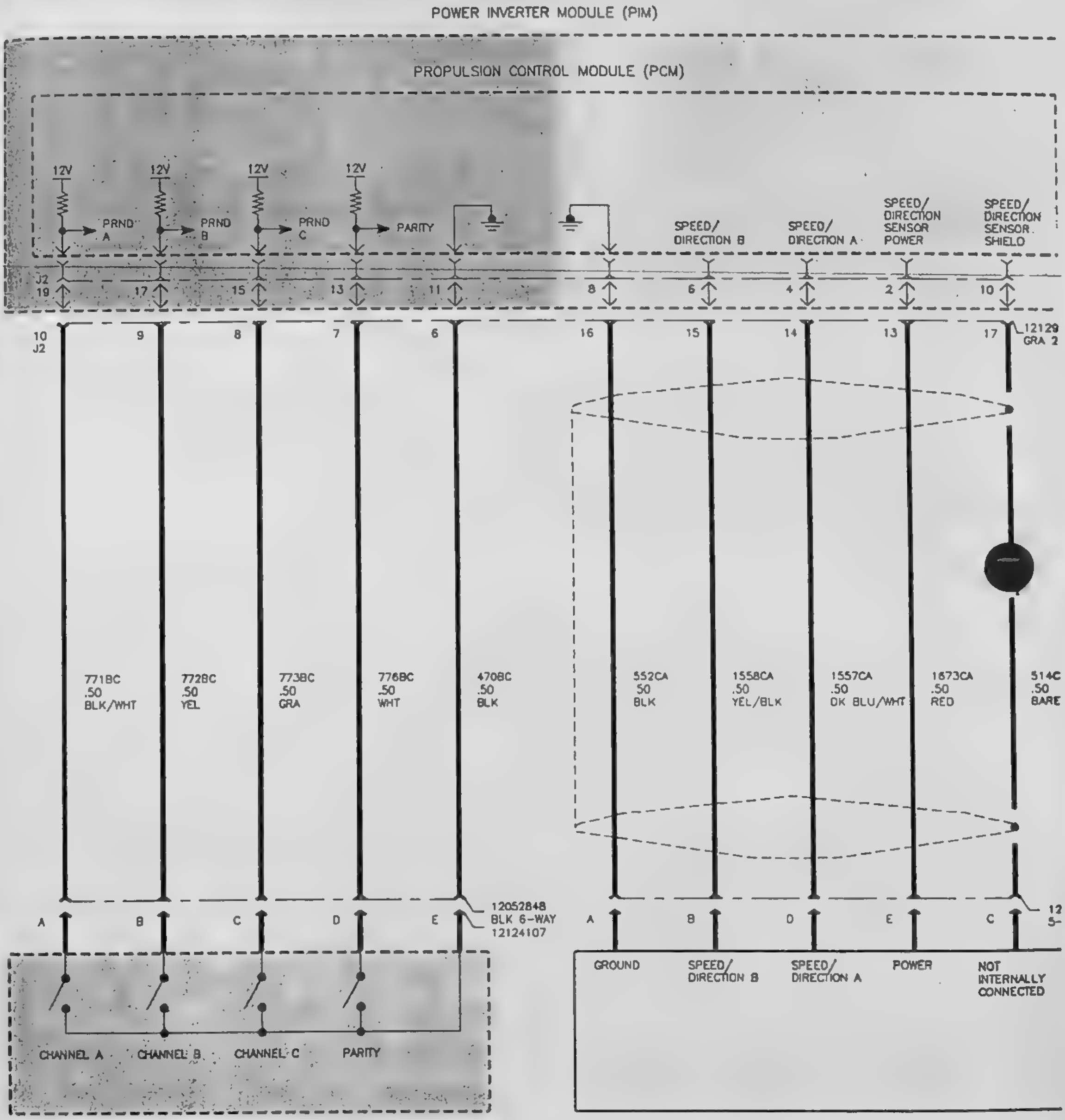
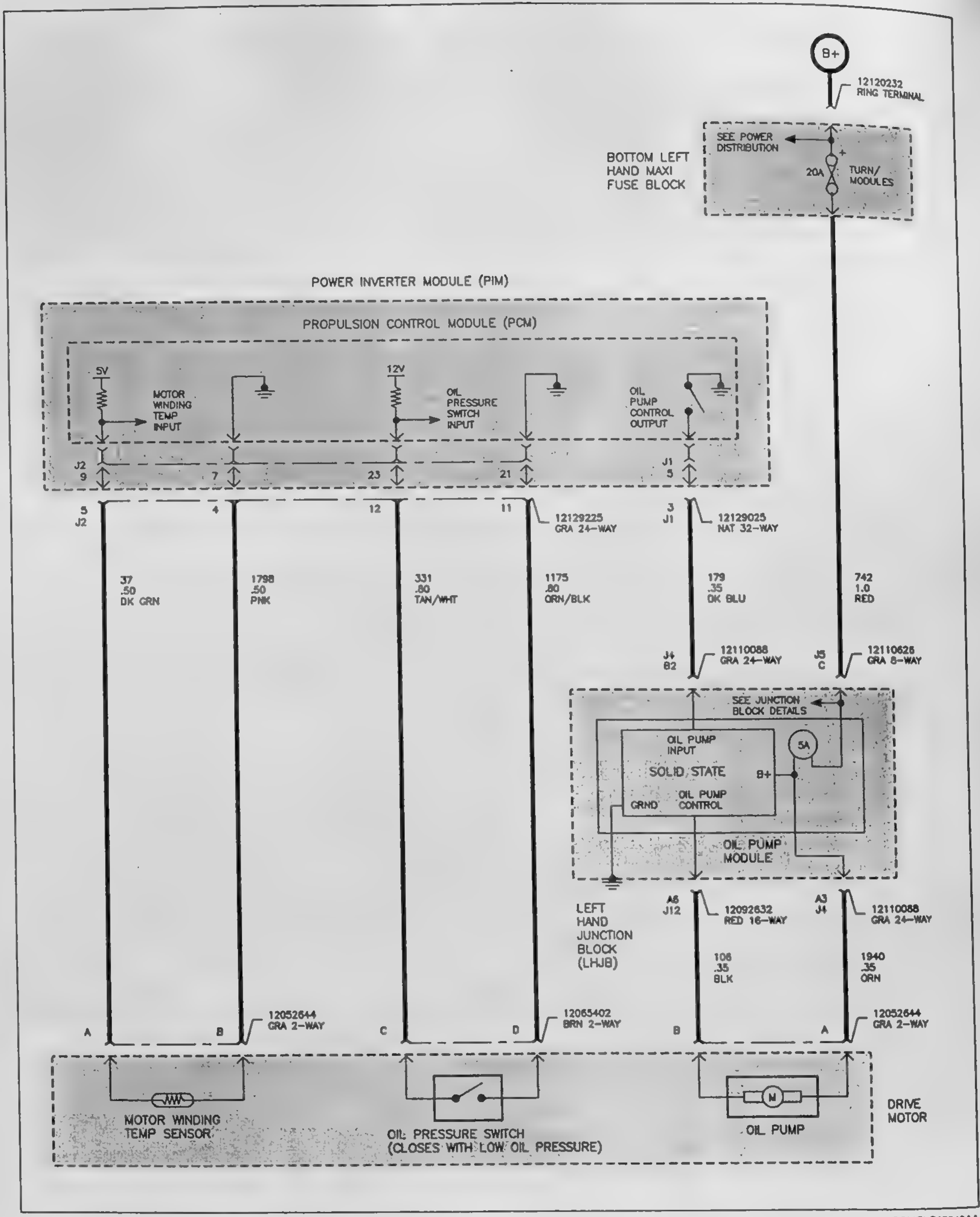
PROPULSION (LOW VOLTAGE–CONT.)



PARK REVERSE NEUTRAL DRIVE (PRND) SWITCH

DRIVE MOTOR SPEED/DIRECTION SENSOR



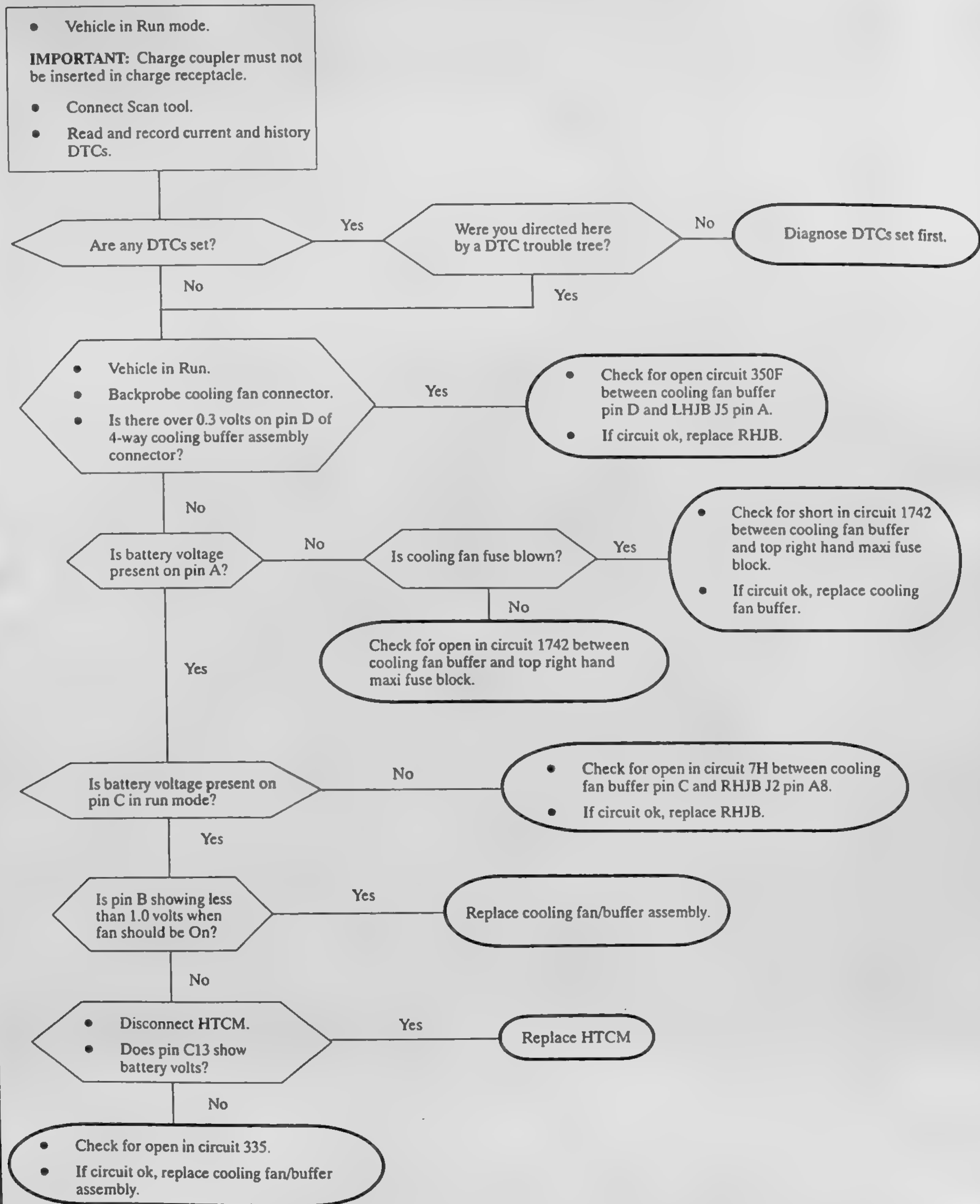
PSMELC67648AA

COOLING SYSTEM

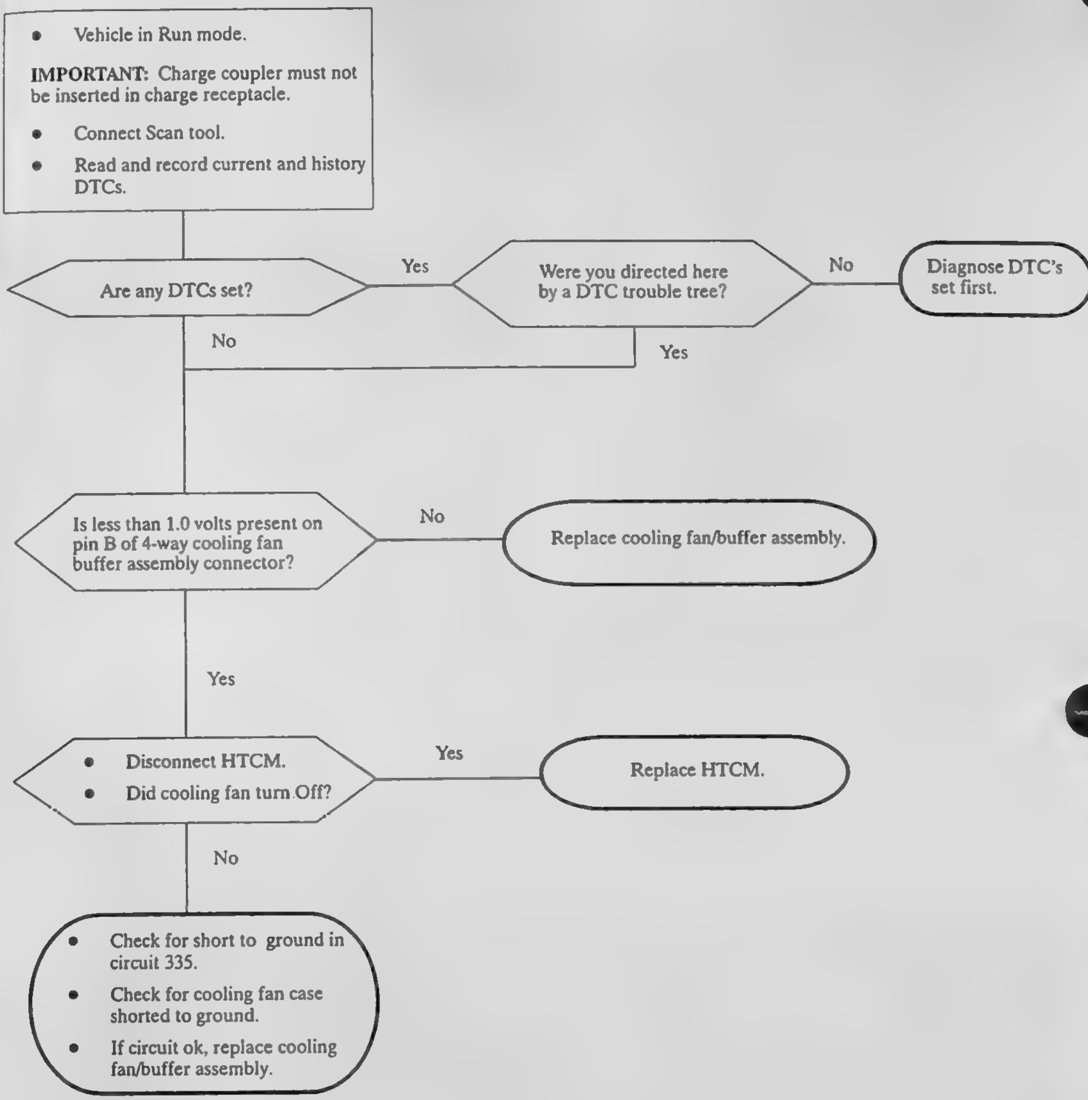
COOLING SYSTEM TROUBLESHOOTING CHART

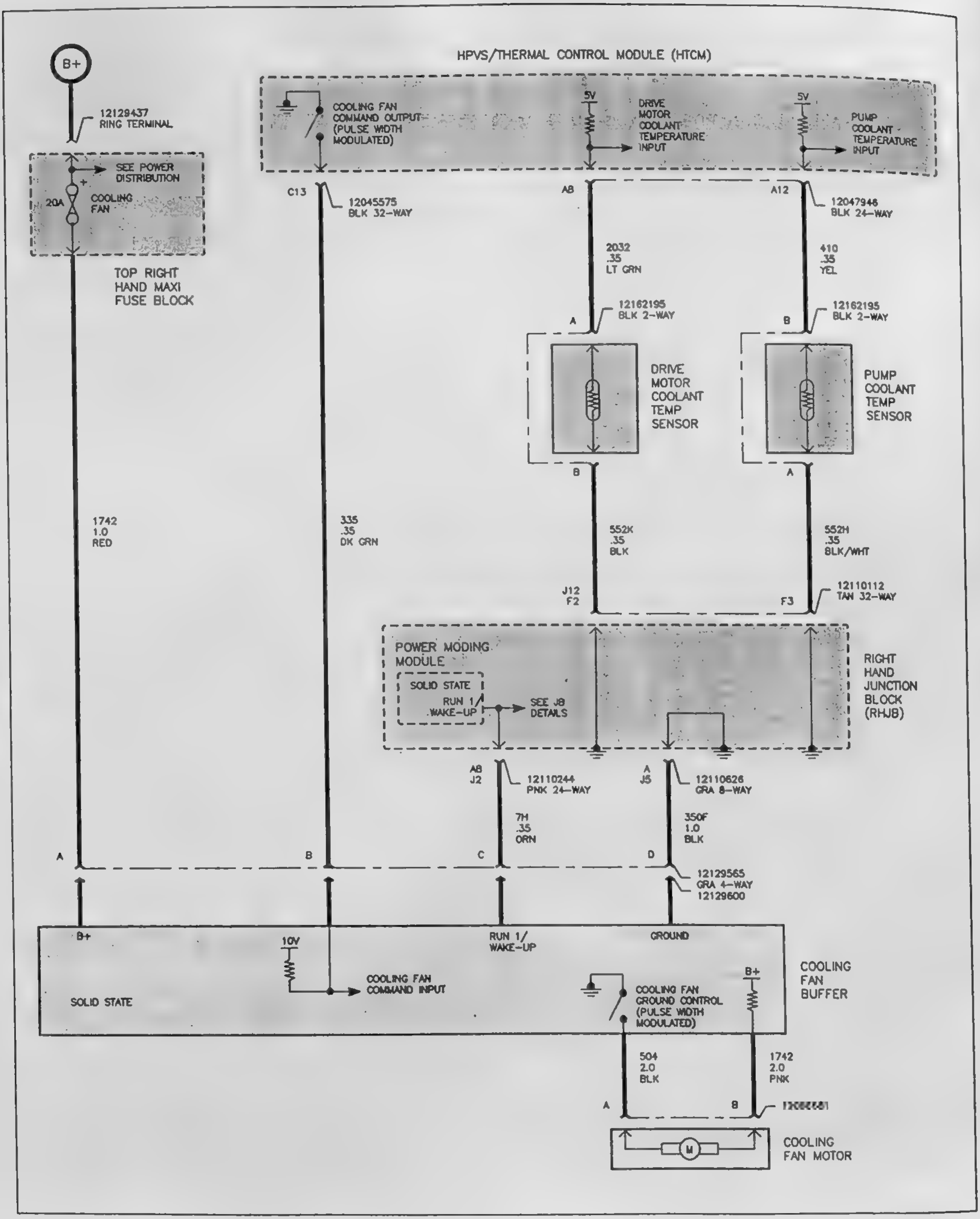
COMPLAINT	POSSIBLE CAUSE(S)	CORRECTION(S)
em Over Temperature	System low on coolant.	Replenish coolant and check for leaks.
	Dirt, leaves, or insects on radiator or condensor.	Clean radiator and/or condenser.
	Hoses, water pump, control valve, charger receptacle valve, radiator leakage.	Repair as necessary.
	Electric cooling fan or sensors.	Inspect cooling fan motor and sensors.
	Radiator hose plugged or rotted.	Replace radiator hose.
	Radiator plugged.	Inspect, test, and/or replace radiator.
	Coolant expansion tank pressure valve damaged.	Replace cooling expansion tank.
	Vehicle air dam/inlet duct damaged, cracked or missing.	Replace air dam/inlet duct.
	Coolant solution.	Check protection.
olant Loss	Check coolant expansion tank.	Replace if necessary.
	Leaks: Check hoses, hose clamps, water pump, coolant recovery check valve, charger receptacle valve, charge port and heater core.	Repair if necessary.
gine Cooling Fan Inoperative	Engine cooling fan circuit.	Reference cooling fan circuit chart "Cooling Fan Inoperative"
gine Cooling Fan Operates All the ne	Engine cooling fan circuit.	Reference cooling fan circuit chart "Cooling Fan Stays On"

COOLING FAN INOPERATIVE



DTC BB
COOLING FAN STAYS ON





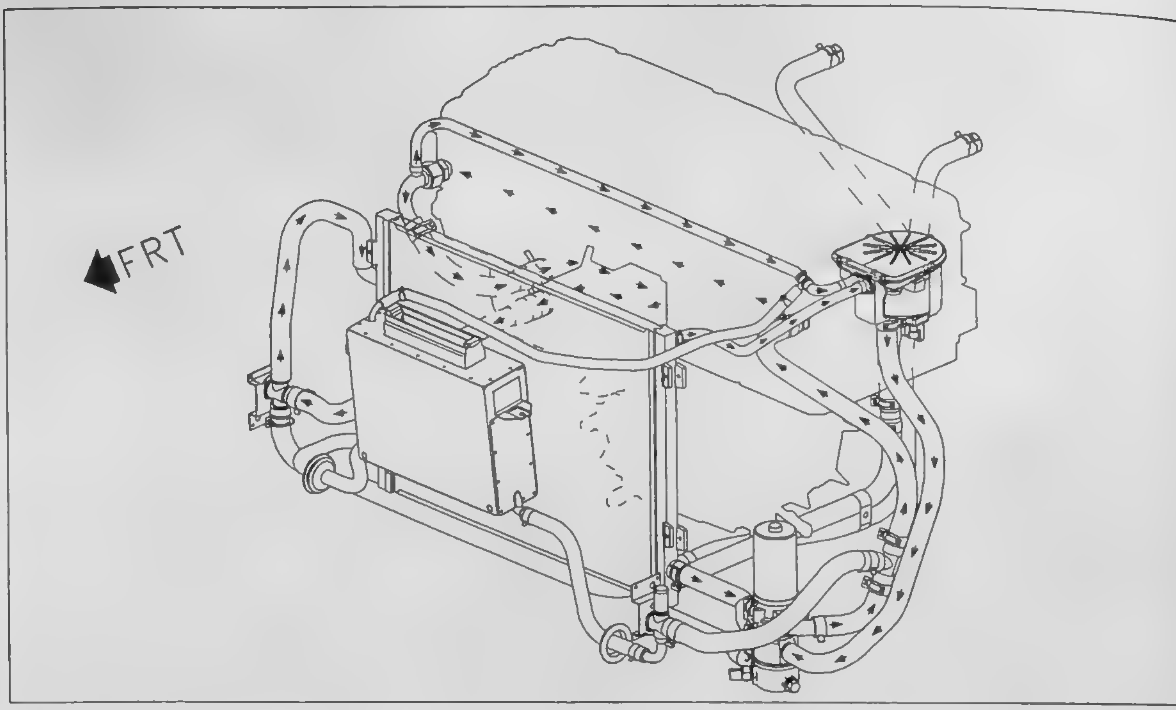
PSMELC68137AA

THERMAL COOLING SYSTEM

MEASUREMENT	STANDARD		SERVICE LIMIT	
	METRIC	ENGLISH	METRIC	ENGLISH
Radiator				
Capacity – Thermal Cooling System (Including Expansion Tank)	6.5L	6.4 qt.	—	—
1997 Vessel Pressure Relief (Snap on Cover)				
Vent Open Pressure	0 - 1.4 kPa	0 - 2 psi	0 - 1.4 kPa	0 - 2 psi
Vacuum Relief Setting	0 - 1.4 kPa	0 - 2 psi	0 - 1.4 kPa	0 - 2 psi
	At Atmospheric Pressure		—	—
1998 Expansion Tank Pressure Cap (Screw on Cover)				
Cap Opening Pressure	34 - 48 kPa	5 - 7 psi	34 - 48 kPa	5 - 7 psi
Vacuum Relief Setting	0 - 6.8 kPa	0 - 1 psi	—	—
	Below Atmospheric Pressure		—	—
Electric Coolant Pump				
Pump rpm at 12v	3675 rpm		3675 rpm	
Capacity at 12v	18.92 L/min.	20 qt./min.	18.92 L/min.	20 qt./min.
Pump rpm at 5v	1482 rpm		1482 rpm	
Capacity at 5v	5.68 L/min.	6 qt./min.	5.68 L/min.	6 qt./min.
Cooling Fan				
Fan On	Driving 61°C (140°F) Charging 27°C (80°F) On with Heat Pump System		—	
Antifreeze/Coolant	Silicate Free Premixed Orange		ELECTRA-COOL™ Part# 27002485 GM Spec 9986100	

COOLANT SYSTEM FLOW SCHEMATIC

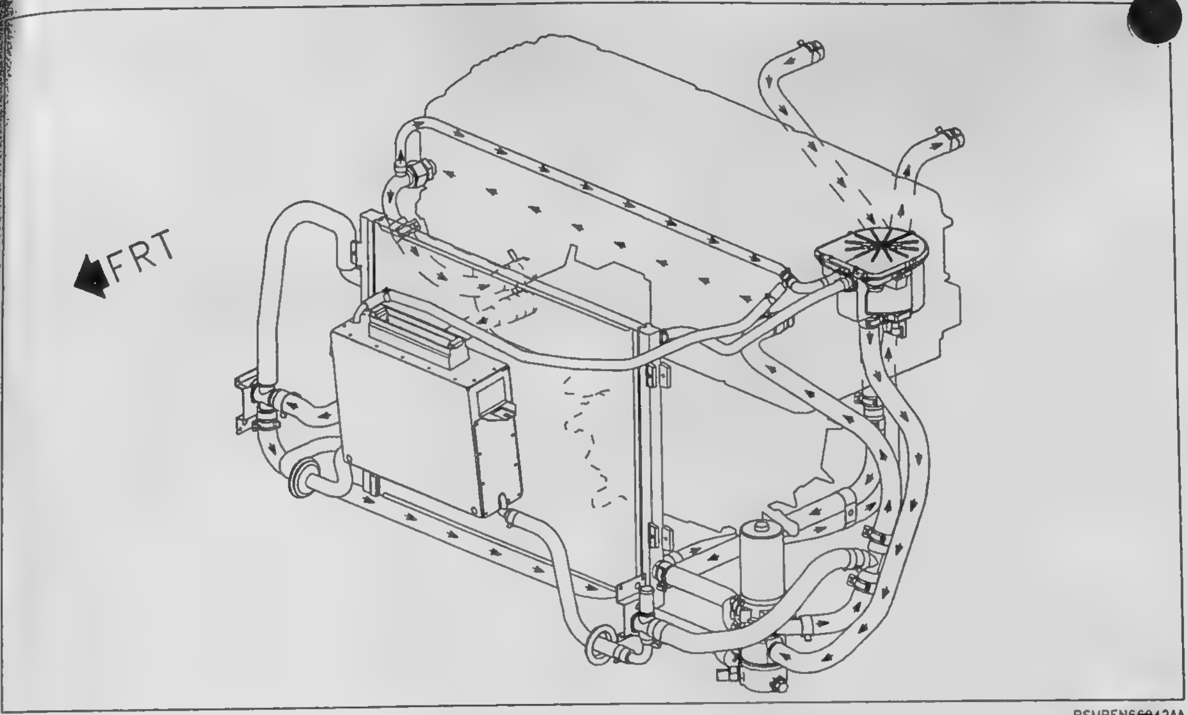
RUN MODE WITHOUT WASTE HEAT



PSMPEN66942AA

In the Run mode with out waste heat the coolant flows from the coolant pump outlet to the power electronics bay (PEB) inlet located on the left front side of the power inverter module (PIM). The coolant flows through the PEB to the outlet which is located on the right front side of the PIM and then flows to the drive motor inlet which is the upper hose, a small portion of the coolant is sent from the PIM outlet connector to the coolant expansion tank located on the left front strut tower. The coolant flows through the drive motor to the outlet which is the lower hose and then flows to the coolant recovery check valve inlet which is the center hose facing inboard. When the heater is in the off position the coolant is directed to the radiator inlet which is the right upper hose from the coolant recovery check valve outlet which is located on the top of the valve. The coolant passes through the radiator to the outlet located at the right side lower and out to the coolant pump manifold.

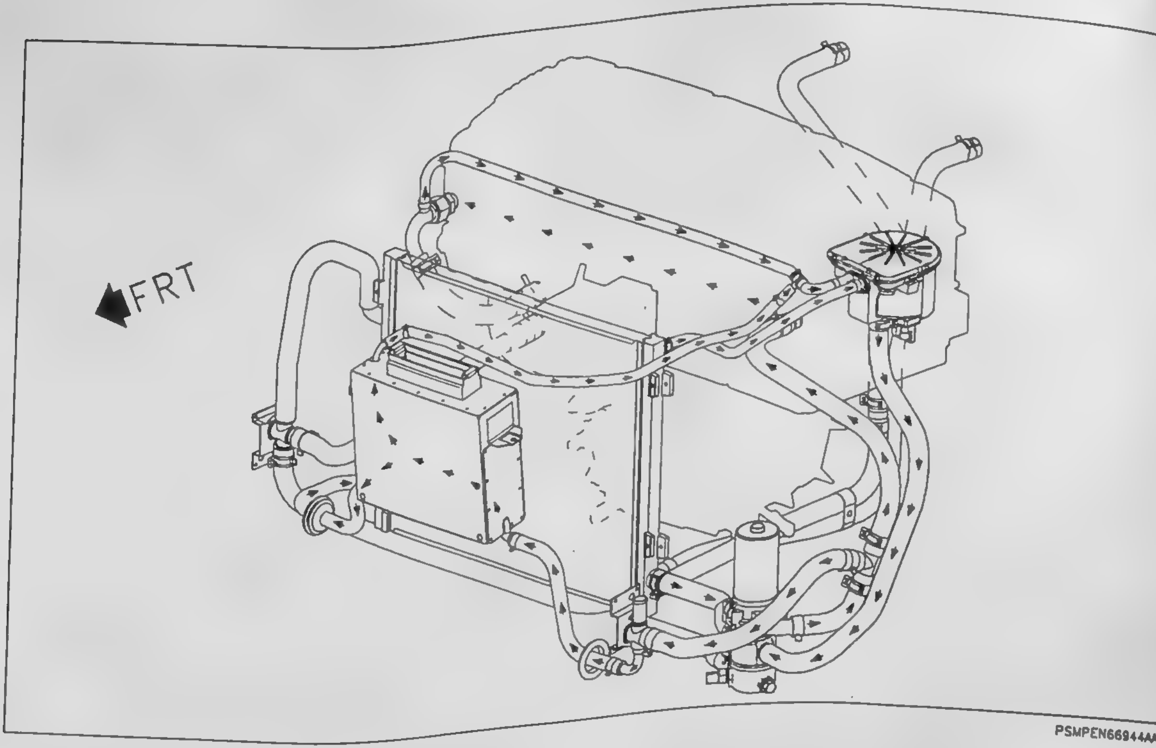
RUN MODE WITH WASTE HEAT



PSMPEN66042AA

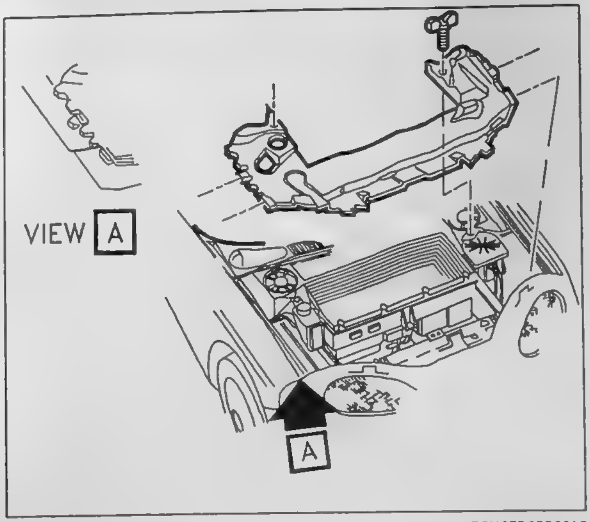
In the Run mode with waste heat the coolant flows from the coolant pump outlet to the power electronics bay (PEB) inlet located on the left front side of the power inverter module (PIM). The coolant flows through the PEB to the outlet which is located on the right front side of the PIM and then flows to the drive motor inlet which is the upper hose, a small portion of the coolant is sent from the PIM outlet connector to the coolant expansion tank located on the left front strut tower. The coolant flows through the drive motor to the outlet which is the lower hose and then flows to the coolant recovery check valve inlet which is the center hose facing inboard. When the heater is in the on position the coolant is directed through the coolant recovery check valve to the heater inlet hose located on the bottom of the valve. The coolant passes through the heater core to the heater outlet hose and returns to the coolant pump manifold inlet.

OFF MODE WHEN CHARGING BATTERIES



PSMPEN66944AA

In the Off mode when battery charging is occurring the coolant flows from the coolant pump outlet to the drive motor battery charger receptacle coolant valve inlet and power electronics bay (PEB) inlet. When charging the valve is opened to allow coolant to flow to the charger receptacle. The coolant flows through the charger receptacle to the charger receptacle outlet hose which goes to the radiator, a small portion of the coolant is sent to the coolant expansion tank through the charger receptacle vent hose. The coolant passes through the radiator to the outlet located at the left side lower on the radiator and out to the coolant pump manifold.



PSMGEP65869AC

12. Maintain fluid level between "MIN" and "MAX" lines in expansion tank.
13. After one minute remove charger paddle from charger receptacle.
14. Turn HVAC system to vent mode and insert charger paddle into charger receptacle. Verify charger is operating.
15. After two minutes remove charger paddle from charger receptacle. Top off fluid level between "MIN" and "MAX" lines, install cover on expansion tank and check for leaks.
16. Install engine compartment sight shield.

COOLANT LEAK DIAGNOSIS

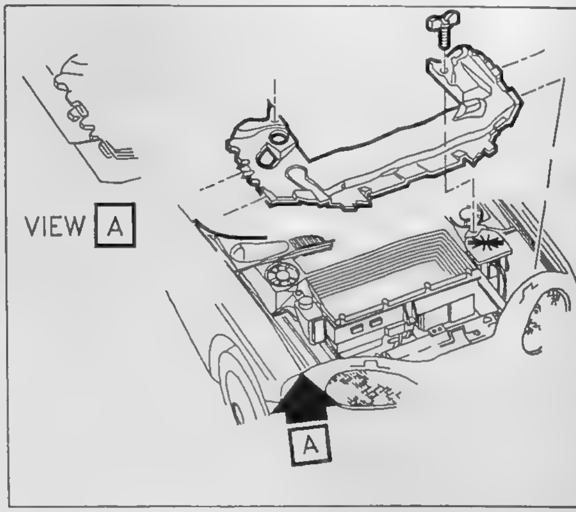
Most coolant leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a coolant leak may be difficult to locate. The following procedure may assist in locating and repairing most leaks. The EV1 uses a low pressure system and pressure testing is not recommended and could damage coolant or drive system components.

1. A Black Light Kit (SA9175NE) and Coolant Dye (PN21007651) or equivalent should be used for finding leaks. Refer to manufacturer's directions when using the kit.
2. Pour specified amount of dye into leaking coolant system.
3. Operate the vehicle under normal operating conditions as directed in the kit.
4. Direct the light toward the suspected area. The dye fluid will appear as a yellow path leading to the source.

TESTING THE COOLANT SYSTEM

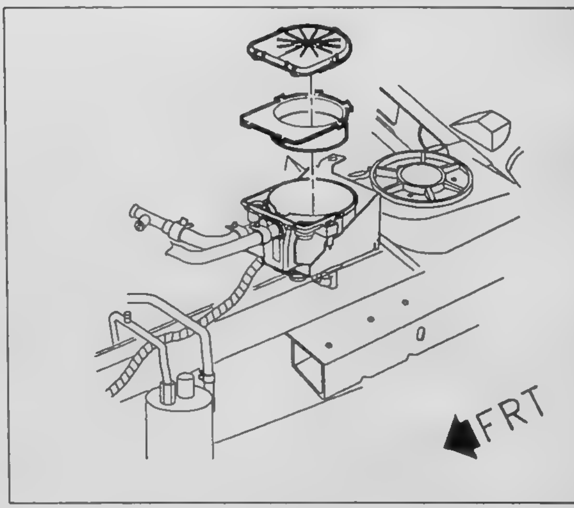
OPERATIONAL TEST

1. Remove engine compartment sight shield.



PSMGEP65869AC

2. Remove expansion tank cover.
3. Place vehicle in "RUN" mode with heater system in the Off mode.

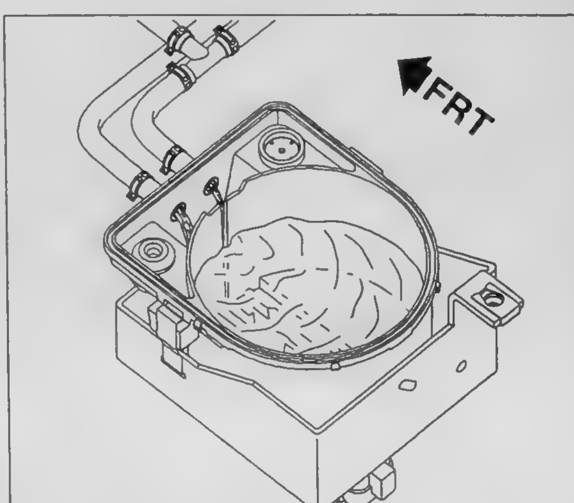


PSMPEN66720AA

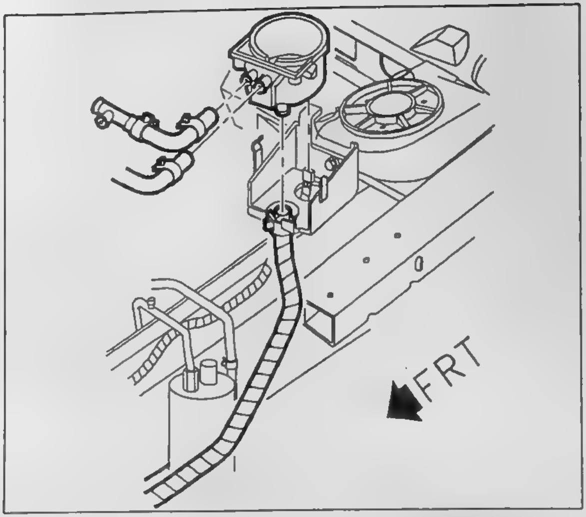
Coolant should be flowing from both vent hoses into the expansion tank. The radiator vent hose on the left side will have a higher volume (thicker) stream as compared to the vent hose on the right. The pressure of the two coolant streams coming into the expansion tank should be about equal. This will indicate that both coolant valves are closed and coolant is being sent through the radiator.

4. Pump voltage can be monitored with the PDT or service stall while performing this test, the pump voltage will vary depending on the coolant temperature.
5. Coolant recovery check valve and drive motor charger receptacle valve can be monitored with the PDT or service stall while performing this test.

By watching the coolant flow from the vents, you can determine if the coolant recovery check valve is moving when cabin heating is requested.

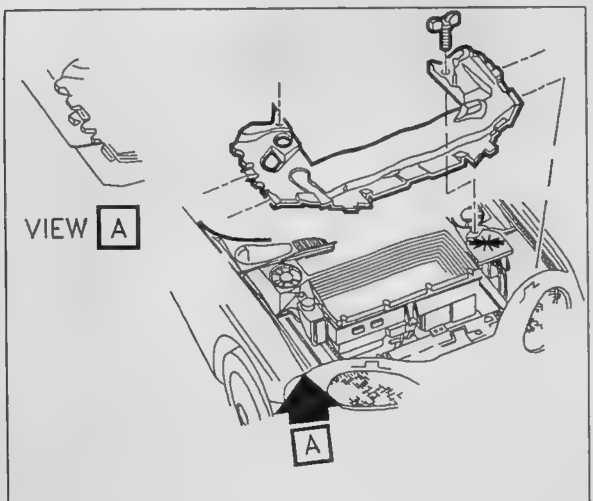


PSMPEN67367AA



PSMPEN66659AA

2. Connect low coolant level switch connector.
3. Align expansion tank body to expansion tank bracket, engage retaining tabs from expansion tank bracket to expansion tank body.
4. Fill coolant system following “Fill Coolant” procedure found in this manual.

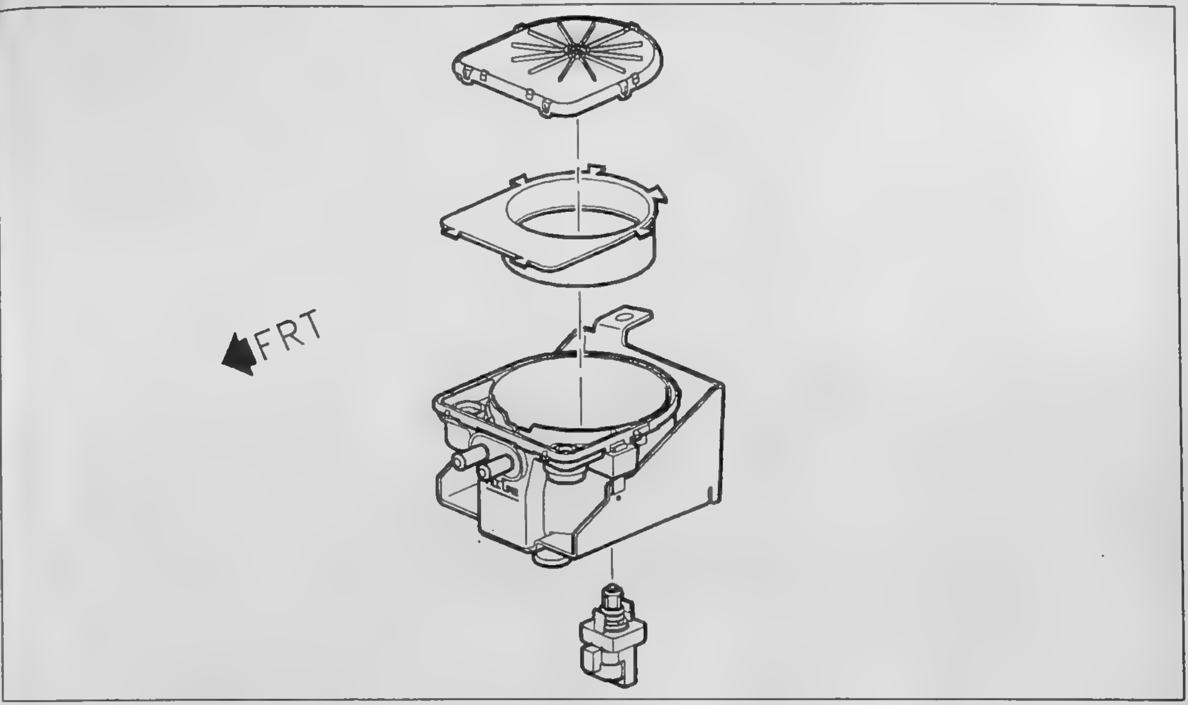


PSMGEP65869AC

5. Install engine compartment sight shield.
6. Install underbody front air deflector assembly. (Refer to “Underbody Front Air Deflector Assembly” in this manual.)

GENERAL DESCRIPTION

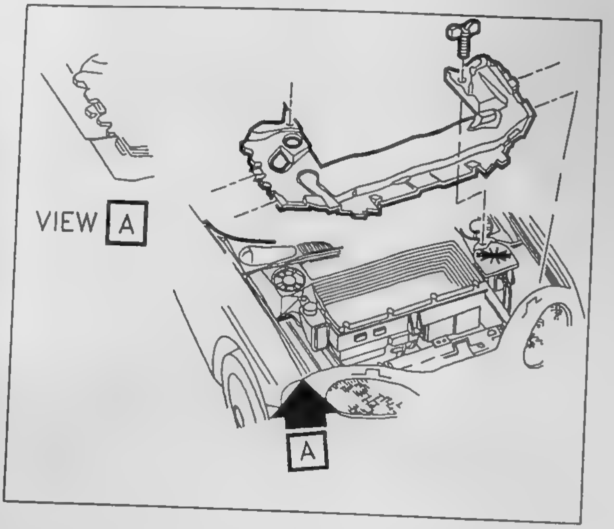
COOLANT EXPANSION TANK (SNAP ON COVER)



PSMPEN66999AA

The coolant expansion tank is made of molded composite material. The expansion tank performs several functions. It incorporates a low coolant switch that will turn on a light in the tell tale bank that signals the coolant level is low. Two pressure relief valves and a diaphragm to maintain 14 +/− kPa (2+/− psi) of atmospheric pressure with in the coolant system. The expansion tank is also used as a air separator and thermal expansion tank.

There could be some traces of coolant seepage from the pressure relief valves. This would be considered normal operation of the expansion tank. This would normally occur if the expansion tank was overfilled.



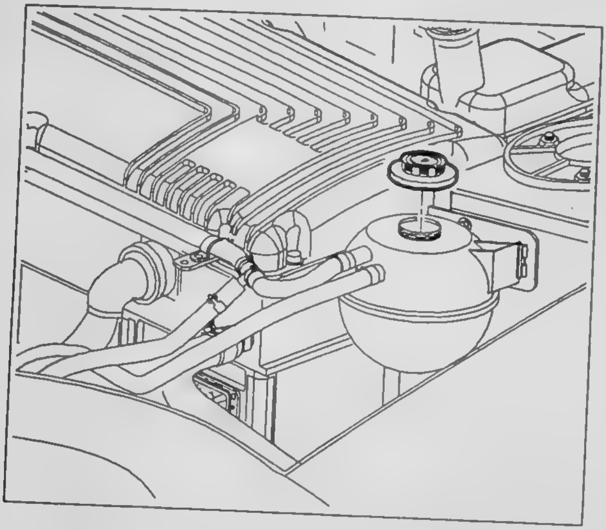
PSMGEP65869AC

COOLANT EXPANSION TANK BRACKET (SCREW ON COVER)

CAUTION: DO NOT REMOVE EXPANSION TANK COVER OR OPEN COOLING SYSTEM DRAINS FROM A HOT SYSTEM. ALLOW SYSTEM TO COOL FIRST.

REMOVAL

1. Remove engine compartment sight shield.

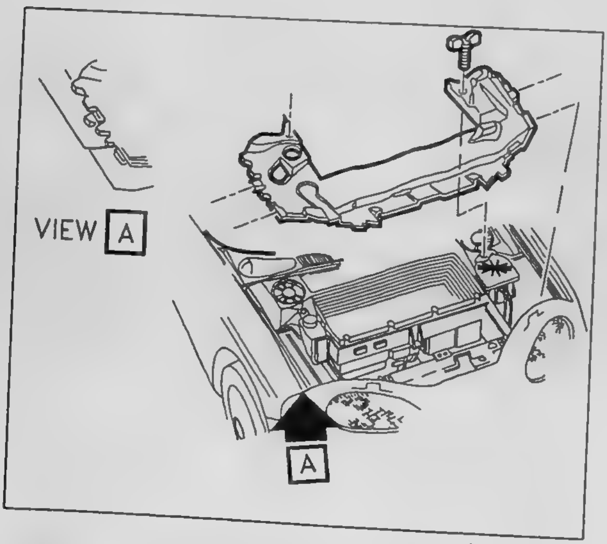


PSMPEN72765AA

2. Unscrew expansion tank cover.

INSTALLATION

1. Screw on expansion tank cover until cover ratchets when tight.



PSMGEP65869AC

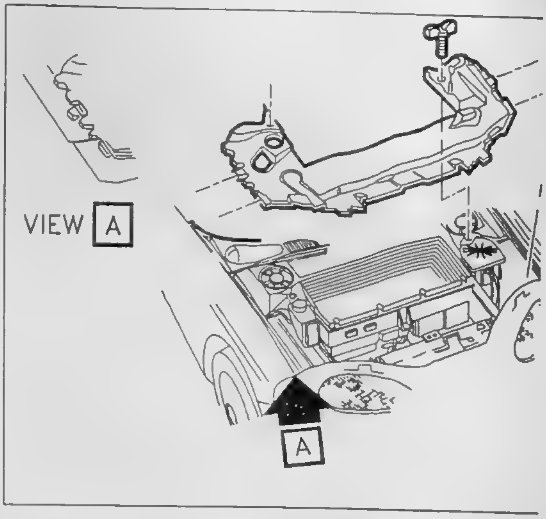
2. Install engine compartment sight shield

COOLANT EXPANSION TANK BRACKET (SCREW ON COVER)

CAUTION: DO NOT REMOVE EXPANSION TANK COVER OR OPEN COOLING SYSTEM DRAINS FROM A HOT SYSTEM. ALLOW SYSTEM TO COOL FIRST.

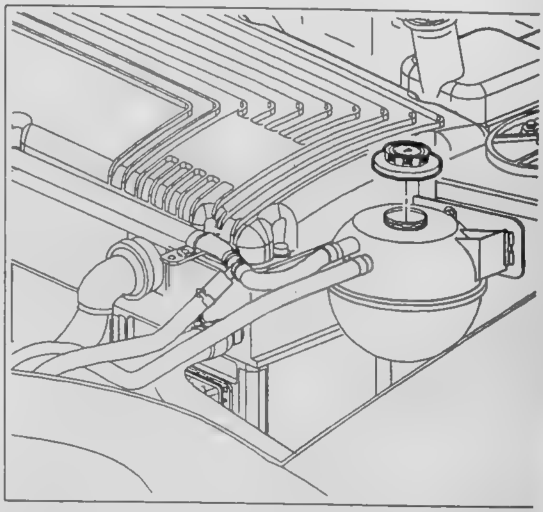
REMOVAL

1. Remove engine compartment sight shield.



PSMCEP65

2. Remove the expansion tank cover.
3. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this service manual.)
4. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this service manual.)



PSMPEN7

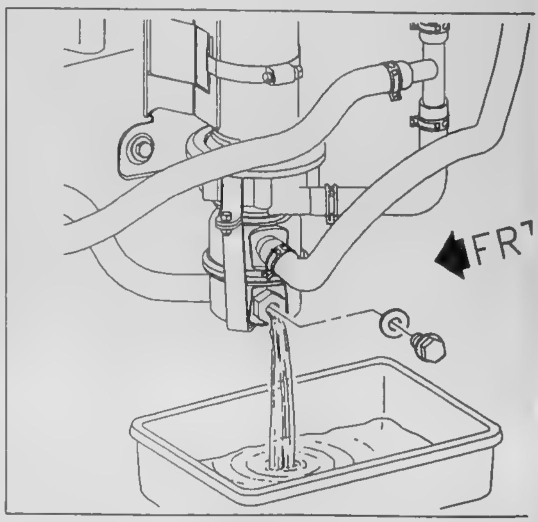
5. Position drain pan under coolant pump manifold.

IMPORTANT: A two gallon container will be required to hold the coolant.

6. Remove the drain plug from the coolant pump manifold allowing the coolant to flow from the main path into container.
7. After coolant has drained from the main path reinstall coolant pump manifold drain plug.

Torque: 11 N•m (97 in–lbs)

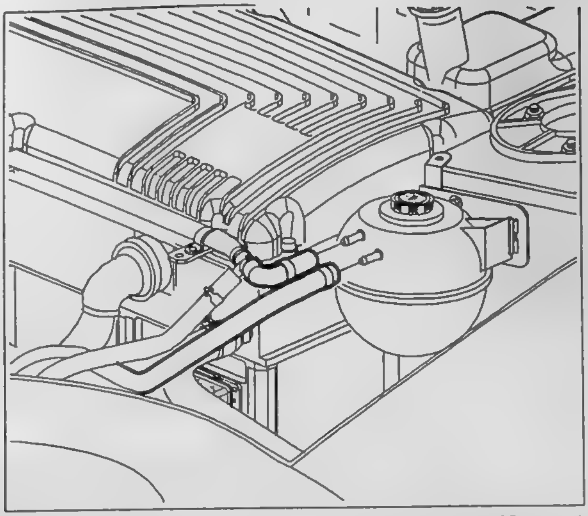
8. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this service manual.)
9. Lower vehicle on hoist.



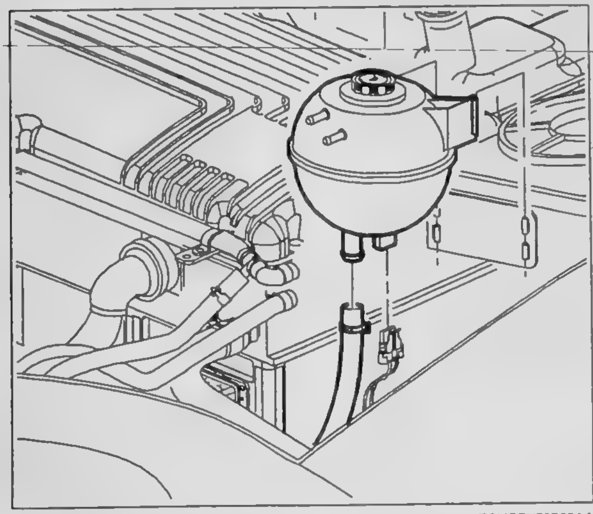
PSMPENE

10. Disconnect coolant recovery expansion tank inlet hose from expansion tank.

11. Disconnect radiator vent hose from expansion tank.



PSMPEN72766AA



PSMPEN72763AA

12. Disconnect expansion tank bracket from expansion tank body by releasing locking tab at bottom of bracket and sliding tank upward.

13. Disconnect coolant recovery expansion tank outlet hose from expansion tank body.

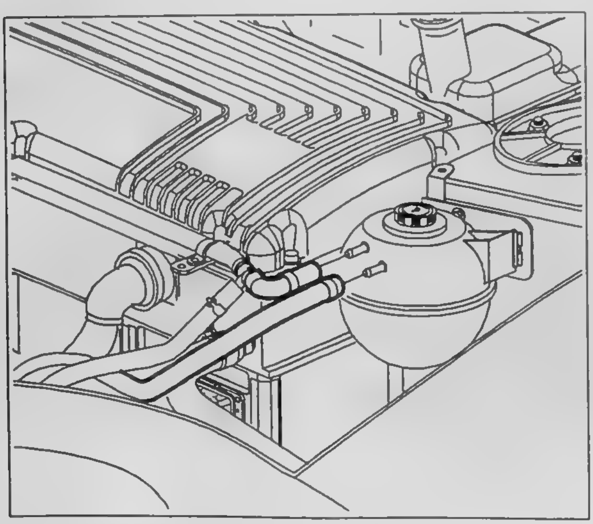
14. Disconnect low coolant sensor connector.

INSTALLATION

1. When installing new expansion tank remove low coolant sensor from old tank and install in new tank refer to “Low Coolant Level Switch Removal and Installation” in this manual.

2. Connect coolant recovery expansion tank outlet to expansion tank body. Position clamp tangs to 3 o’clock.

3. Align expansion tank body to expansion tank bracket and slide downward engaging locking tab.



PSMPEN72766AA

4. Connect radiator vent outlet hose to expansion tank body. Position clamps to 9 o’clock.

5. Connect coolant recovery expansion tank inlet hose to expansion tank. Position clamp tangs to 12 o’clock.

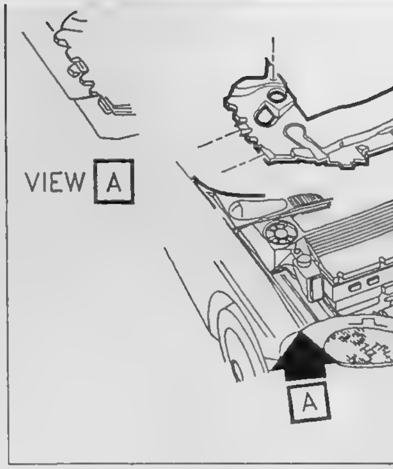
6. Fill coolant system following “Fill” procedure found in this service manual.

COOLANT EXPANSION TANK BRACKET (SCREW ON COVER)

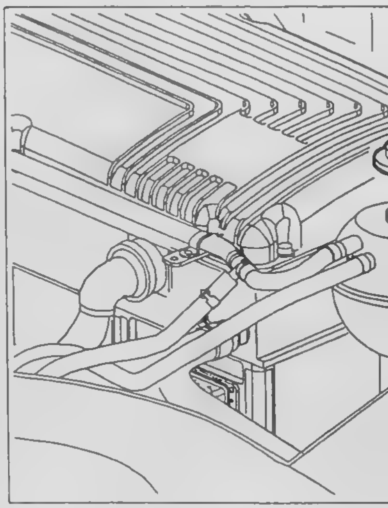
CAUTION: DO NOT REMOVE EXPANSION TANK COVER OR OPEN COOLING SYSTEM DRAINS FROM A HOT SYSTEM. ALLOW SYSTEM TO COOL FIRST.

REMOVAL

1. Remove engine compartment sight shield.



2. Remove the expansion tank cover.
3. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this service manual).
4. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



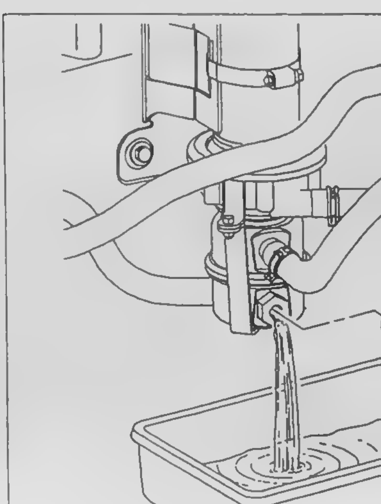
5. Position drain pan under coolant pump manifold.

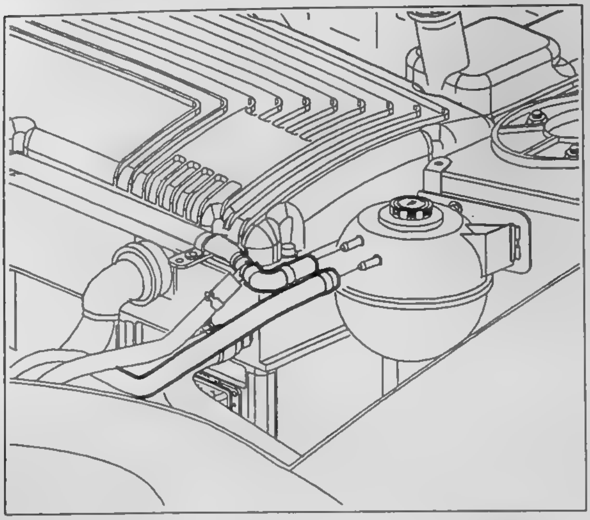
IMPORTANT: A two gallon container will be required to hold the coolant.

6. Remove the drain plug and gasket from the coolant pump manifold allowing the coolant to flow from the main path into container.
7. After coolant has drained from the main path reinstall coolant pump manifold drain plug and gasket.

Torque: 11 N•m (97 in−lbs)

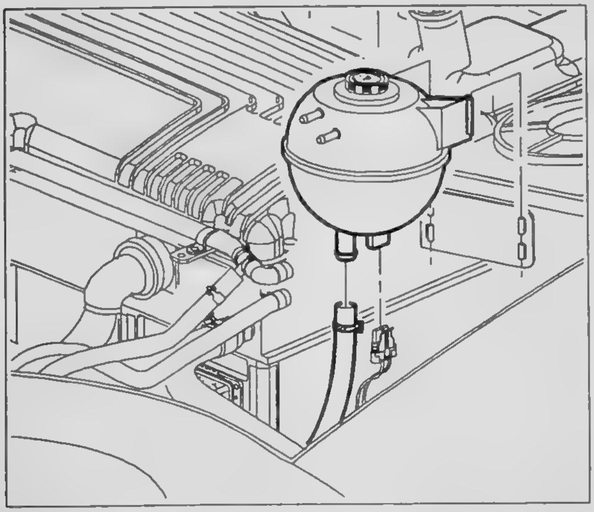
8. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this service manual.
9. Lower vehicle on hoist.





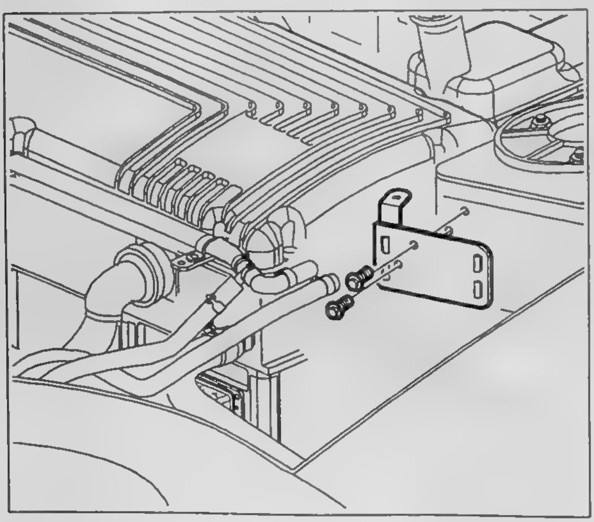
PSMPEN72766AA

10. Disconnect radiator recovery expansion tank inlet hose from expansion tank.
11. Disconnect radiator vent hose from expansion tank.



PSMPEN72763AA

12. Disconnect expansion tank bracket from expansion tank body by releasing the locking tab at bottom of the bracket and sliding the tank upward.
13. Disconnect coolant recovery expansion tank outlet from expansion tank body.
14. Disconnect low coolant sensor connector.



PSMPEN72795AA

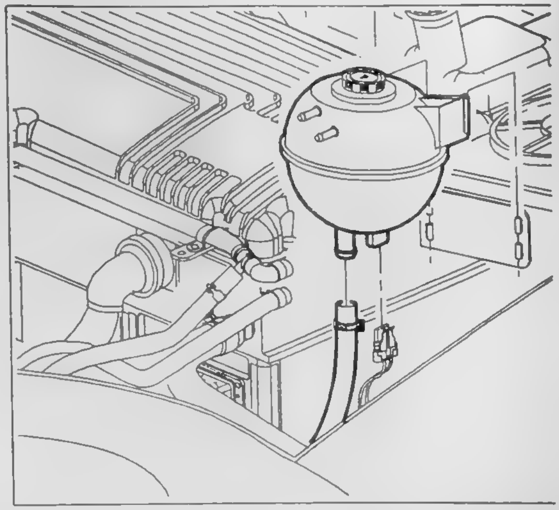
15. Remove expansion tank bracket bolts and remove bracket.

INSTALLATION

1. Align expansion tank bracket to strut tower install bolts.

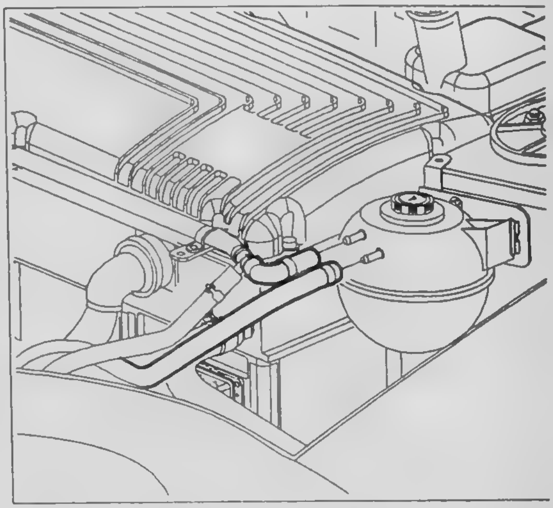
Torque: **6 N•m (53 in−lbs)**

2. Connect coolant recovery expansion tank outlet hose to expansion tank body. Position clamp tangs to 3 o'clock.
3. Connect low coolant level sensor connector.
4. Align expansion tank body to expansion tank bracket and slide downward engaging locking tab.



PSMPEN727

5. Connect radiator vent outlet hose to expansion tank body. Position clamps at 9 o'clock.
6. Connect coolant recovery expansion tank inlet hose to expansion tank. Position clamp tangs to 12 o'clock.
7. Fill coolant system following "Fill" procedure found in this section.



PSMPEN72

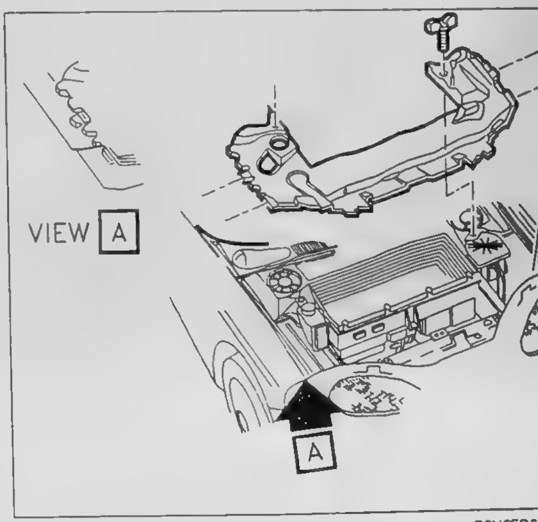
8. Install engine compartment sight shield.

LOW COOLANT LEVEL SWITCH (SCREW ON COVER)

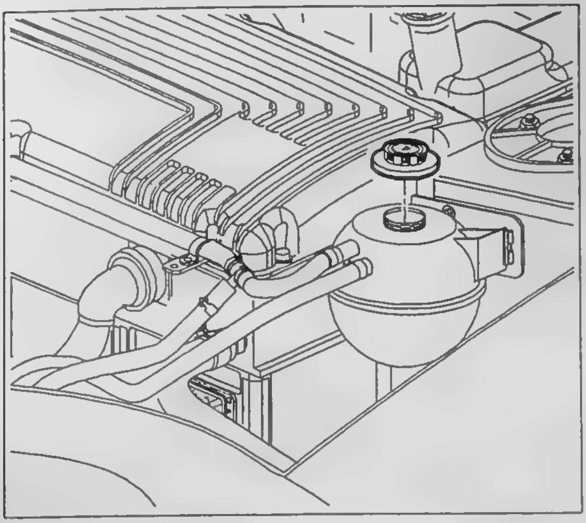
CAUTION: DO NOT REMOVE EXPANSION TANK COVER OR OPEN COOLING SYSTEM DRAINS FROM A HOT SYSTEM. ALLOW SYSTEM TO COOL FIRST.

REMOVAL

1. Remove engine compartment sight shield.

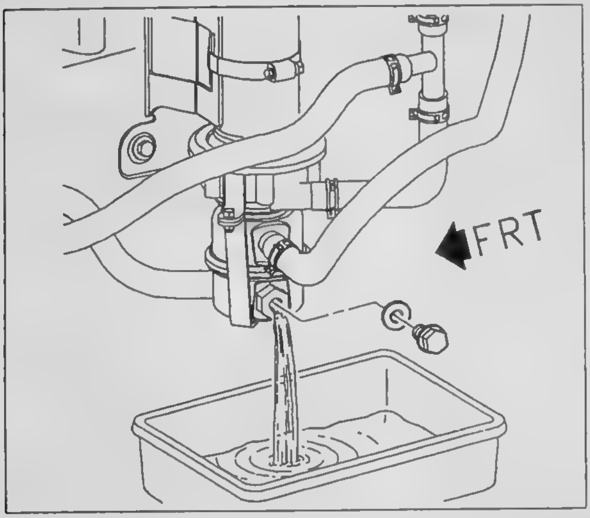


PSMGEP65



PSMPEN72765AA

2. Remove the expansion tank cover.
3. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
4. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



PSMPEN66458AB

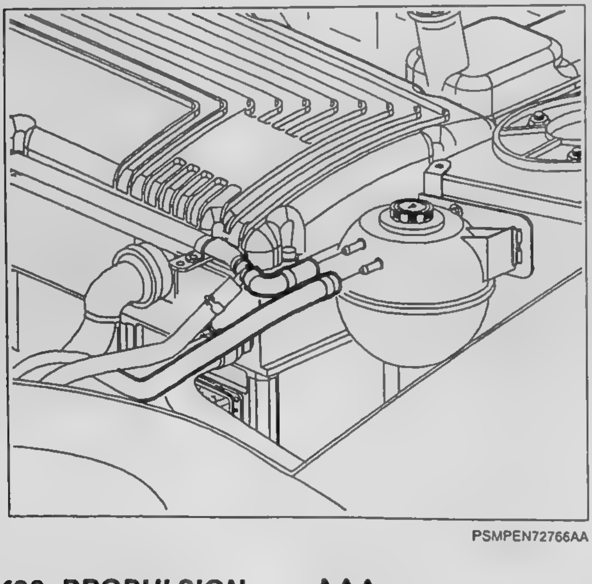
5. Position drain pan under coolant pump manifold.

IMPORTANT: A two gallon container will be required to hold the coolant.

6. Remove the drain plug and gasket from the coolant pump manifold allowing the coolant to flow from the main path into container.
7. After coolant has drained from the main path reinstall coolant pump manifold drain plug and gasket.

Torque: 11 N•m (97 in–lbs)

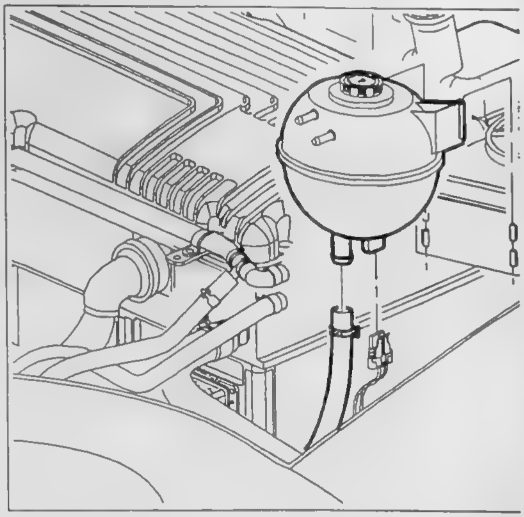
8. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this service manual.
9. Remove vehicle on hoist.



PSMPEN72766AA

10. Disconnect radiator recovery expansion tank inlet hose from expansion tank.
11. Disconnect radiator vent hose from expansion tank.

12. Disconnect expansion tank bracket from expansion tank body by releasing the locking tab at bottom of the bracket and sliding the tank upward.
13. Disconnect coolant recovery expansion tank outlet from expansion tank body.
14. Disconnect low coolant sensor connector.

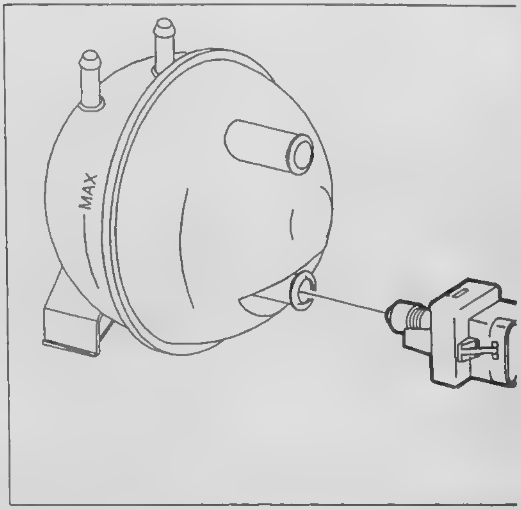


PSMPEN

15. Remove low coolant level switch.

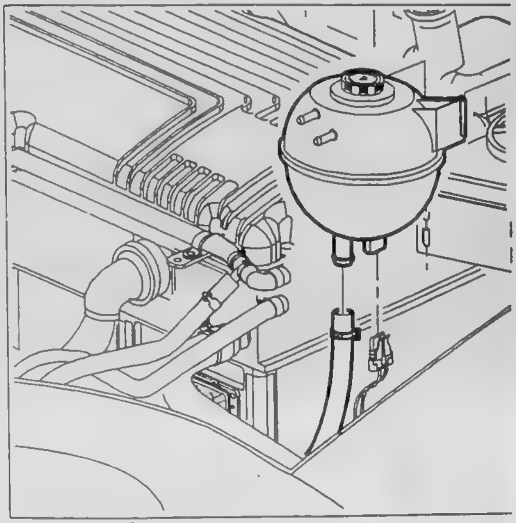
INSTALLATION

1. Install low coolant level switch.

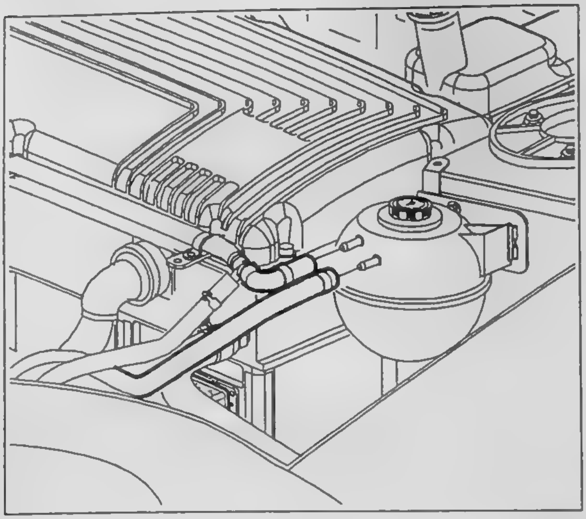


PSMPEI

2. Connect coolant recovery expansion tank outlet hose to expansion tank body. Position clamp tangs to 3 o'clock.
3. Connect low coolant level sensor connector.
4. Align expansion tank body to expansion tank bracket and slide downward engaging locking tab.



PSMPE

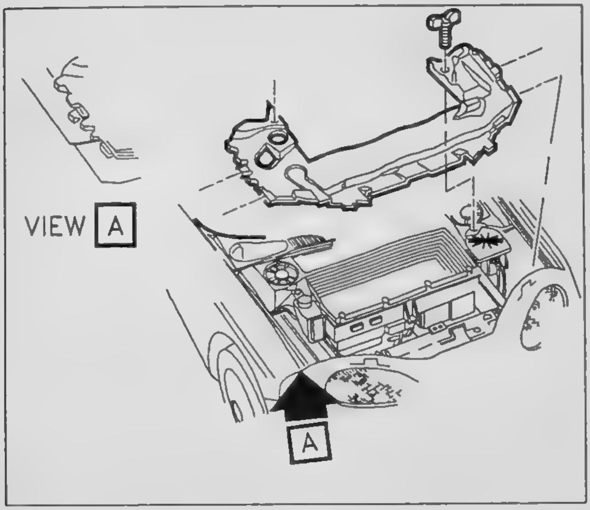


PSMPEN72766AA

5. Connect radiator vent outlet hose to expansion tan body. Position clamps at 9 o'clock.

6. Connect coolant recovery expansion tank inlet hos to expansion tank. Position clamp tangs to 12 o'clo

7. Fill coolant system following "Fill" procedure found in this section.



PSMGEP65869AC

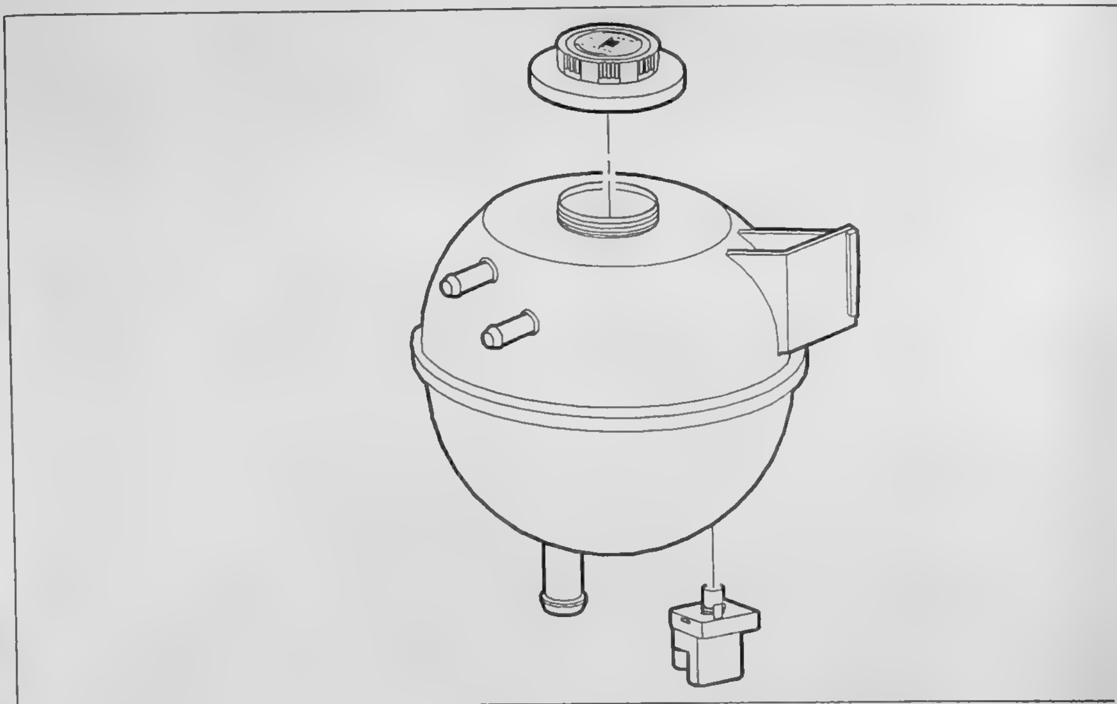
8. Install engine compartment sight shield.

ısion tank

inlet hose
12 o'clock.

ur d

COOLANT EXPANSION TANK (SCREW ON COVER)

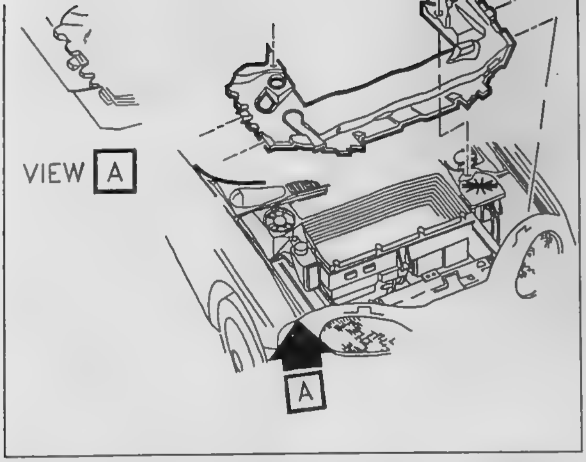


The coolant expansion tank is made of molded composite material. The expansion tank performs several func
It incorporates a low coolant switch that will turn on a light in the tell tale bank that signals the coolant level i
If the coolant level is detected low when charging the batteries charging will be disabled. The expansion tank
used as a air separator and allows room for thermal expansion of the coolant.

The cover has a 6 psi pressure relief and 1 psi vacuum relief. The cover will ratchet when the correct torque is reached.

The coolant system should never be pressure tested, this could cause damage to the propulsion system comp
The cover should always be replaced with an approved EV1 part because the pressure setting are lower on th
compared to internal combustion vehicle and could cause damage the propulsion system components.

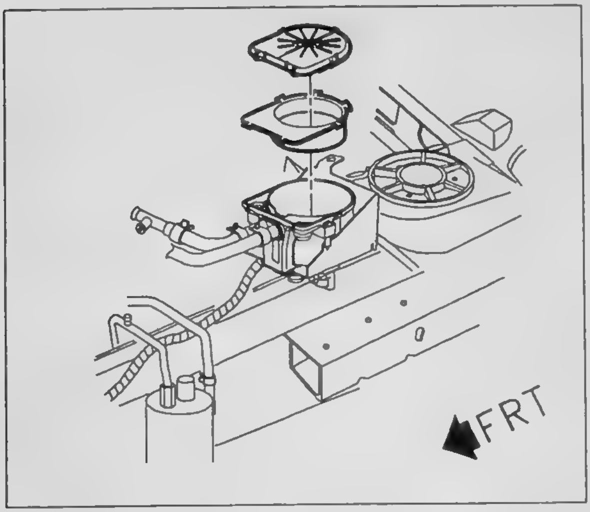
FITTING VEHICLES BUILT WITH 1ST DESIGN (SNAP ON COVER) WITH 2ND DESIGN (SCREW ON COVER) COOLANT BOTTLE



PSMGEP65869AC

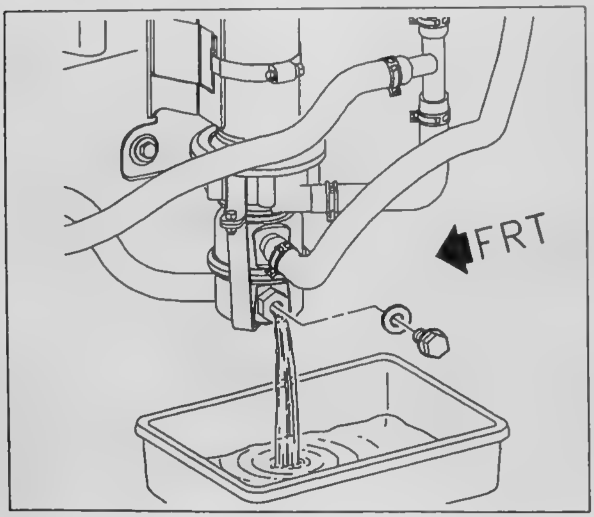
Vehicles built with 1st design snap on cover expansion tanks will be serviced with the 2nd design screw on cover expansion tank. Service parts will only carry the 2nd design expansion tank so when a vehicle built with the 1st design requires a coolant bottle replacement use the following procedure.

1. Remove engine compartment sight shield.



PSMPEN66720AA

2. Remove the expansion tank cover.
3. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this service manual.)
4. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



PSMPEN66458AB

5. Position drain pan under coolant pump manifold.

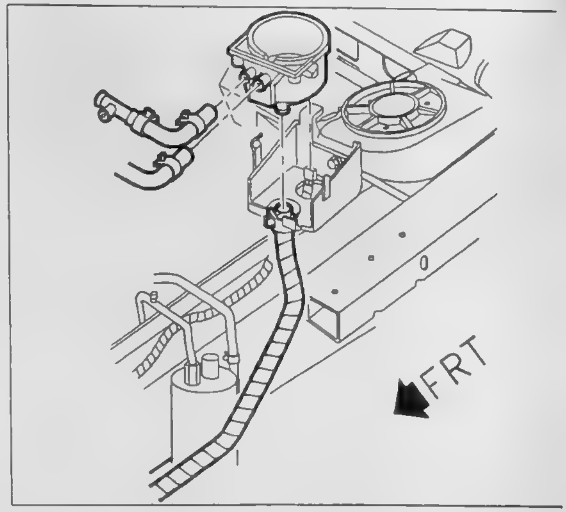
IMPORTANT: A two gallon container will be required to hold the coolant.

6. Remove the drain plug and gasket from the coolant pump manifold allowing the coolant to flow from the main path into container.
7. After coolant has drained from the main path reinstall coolant pump manifold drain plug and gasket.

Torque: 11 N•m (97 in–lbs)

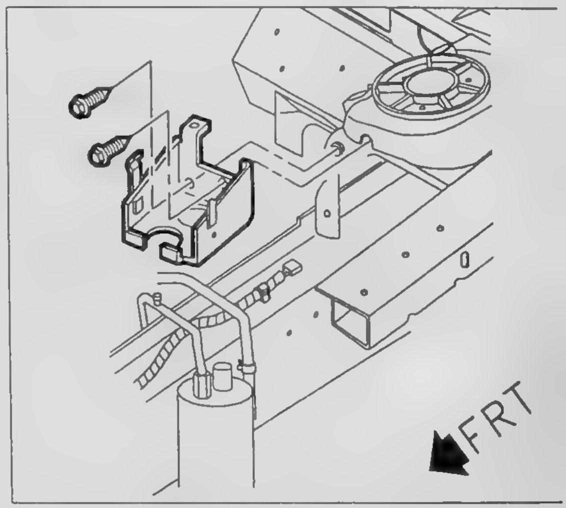
8. Lower vehicle on hoist.

9. Disconnect coolant recovery expansion tank inlet hose from expansion tank. Disconnect radiator vent outlet hose from expansion tank.
10. Disconnect expansion tank bracket from expansion tank body by prying expansion tank bracket tabs outward and sliding expansion tank body upward.
11. Disconnect coolant recovery expansion tank outlet hose from expansion tank body. Disconnect low coolant sensor connector.



PSMPEN6665

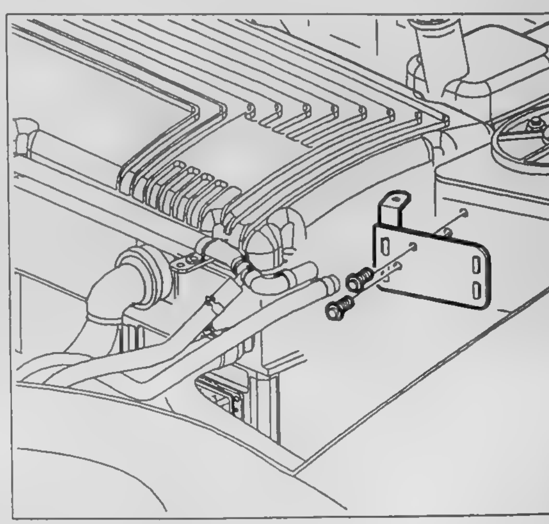
12. Remove 1st design expansion tank bracket bolts and remove bracket.



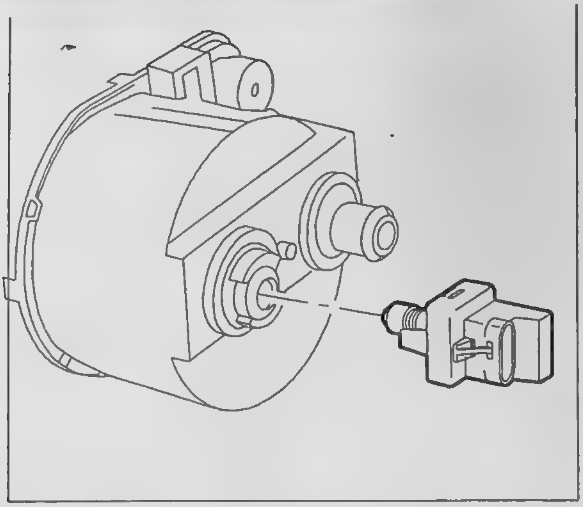
PSMPEN6665

13. Align 2nd design expansion tank bracket to strut tower install bolts.

Torque: **6 N•m (53 in–lbs)**

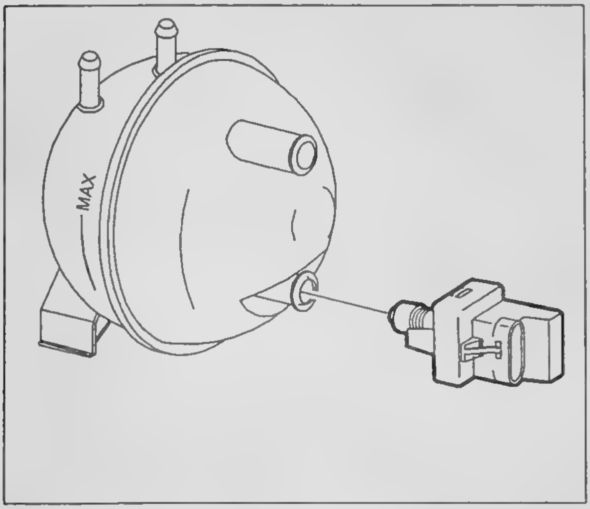


PSMPEN7279



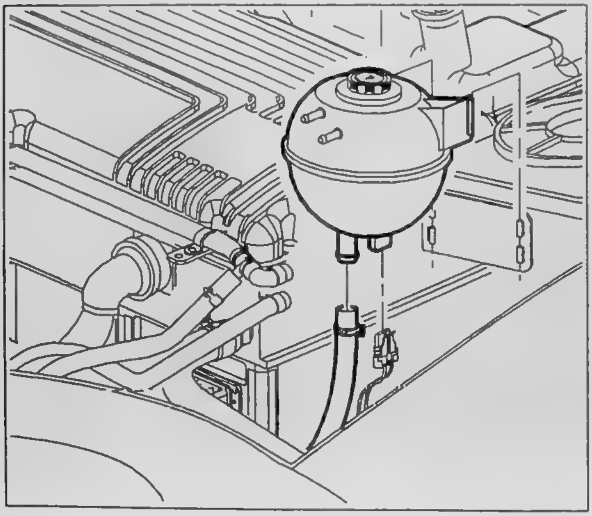
PSMPEN66809AA

14. Remove low coolant level switch from 1st design expansion tank. Discard tank, bracket and cover.



PSMPEN66809AB

15. Install low coolant level switch, removed from 1st design expansion tank into the 2nd design tank.

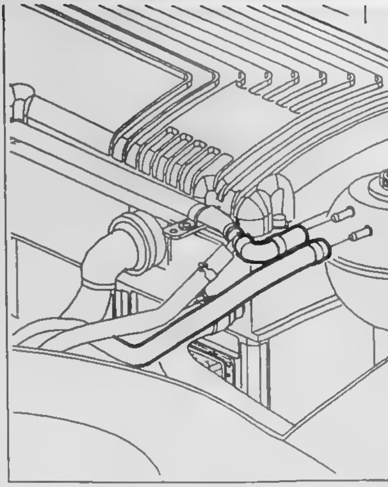


PSMPEN72763AA

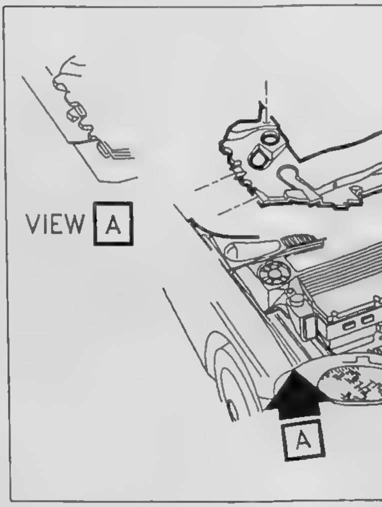
16. Connect coolant recovery expansion tank outlet hose to expansion tank body. Position clamp tangs to 3 o'clock.
17. Connect low coolant level sensor connector.
18. Align expansion tank body to expansion tank bracket and slide downward engaging locking tab.

body. Position clamp tangs to 9 o'clock.

20. Connect coolant recovery expansion tank inlet hose to expansion tank. Position clamp tangs at 12 o'clock.
21. Fill coolant system following "Fill" procedure found in this section.



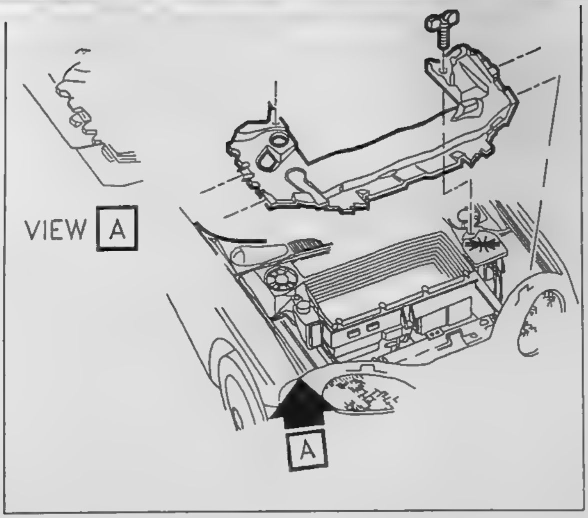
22. Install engine compartment sight shield.



WATER PUMP ASSEMBLY

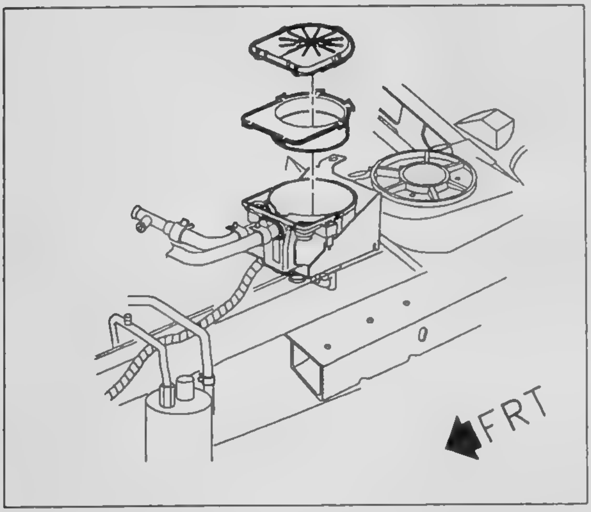
REMOVAL

1. Remove engine compartment sight shield.



PSMGEP65869AC

2. Remove the expansion tank cover.
3. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
4. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



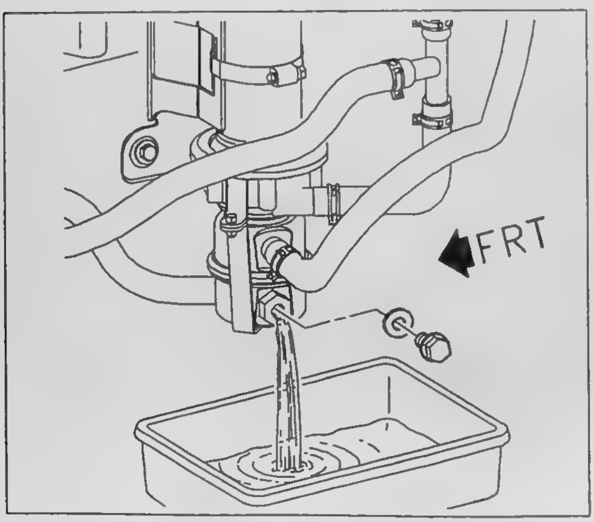
PSMPEN66720AA

5. Position drain pan under coolant pump manifold.

IMPORTANT: A two gallon container will be required to hold the coolant.

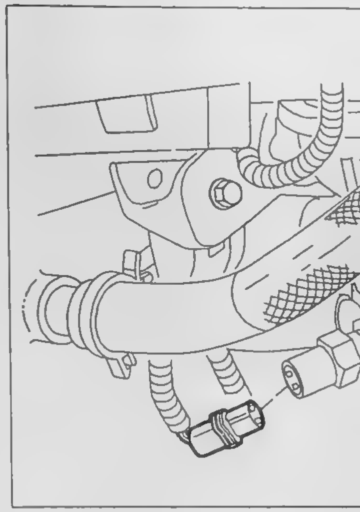
6. Remove the drain plug and gasket from the water pump manifold allowing the coolant to flow from the main path into container.
7. After coolant has drained from the main path reinstall water pump manifold drain plug and gasket.

Torque: **11 N•m (97 in–lbs)**

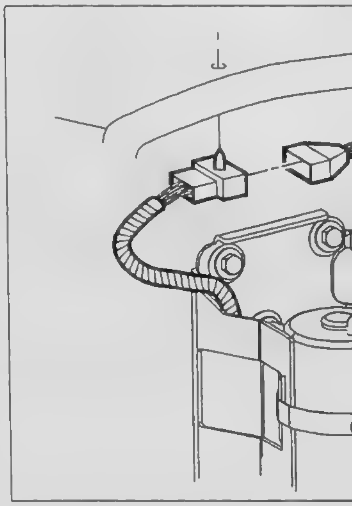


PSMPEN66458AB

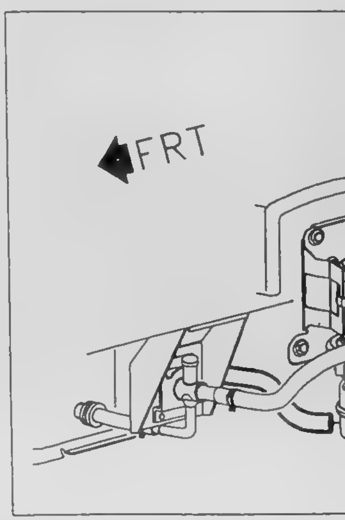
8. Disconnect temperature sensor electrical connector.

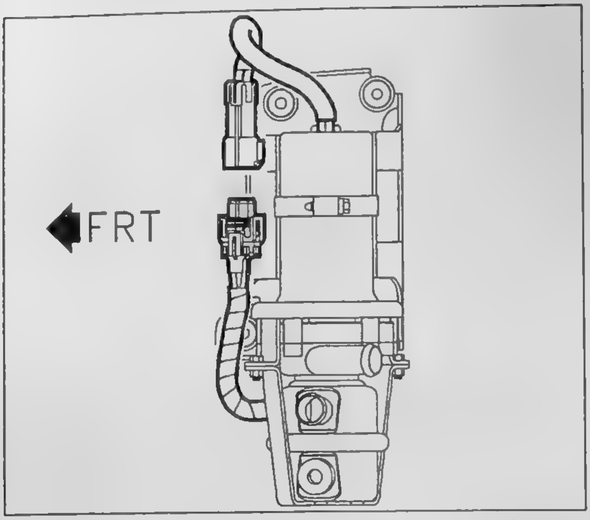


9. Disconnect water pump motor electrical connector.



10. Remove radiator outlet hose at water pump manifold.
11. Remove coolant recovery expansion tank outlet hose at water pump manifold.
12. Remove heater core outlet hose at water pump manifold.
13. Remove water pump outlet hose at water pump.

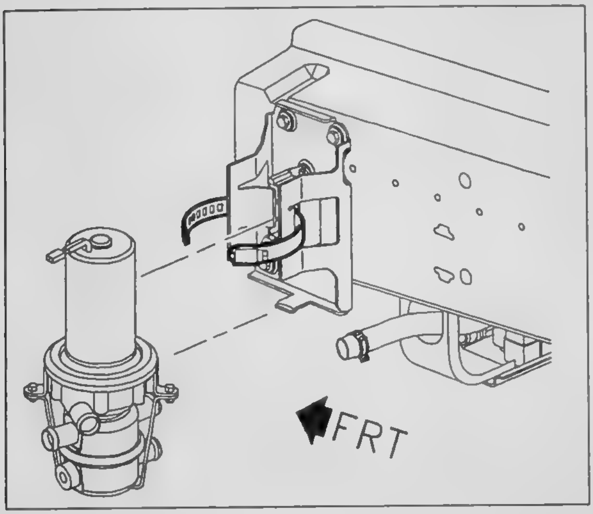




PSMPEN67323AA

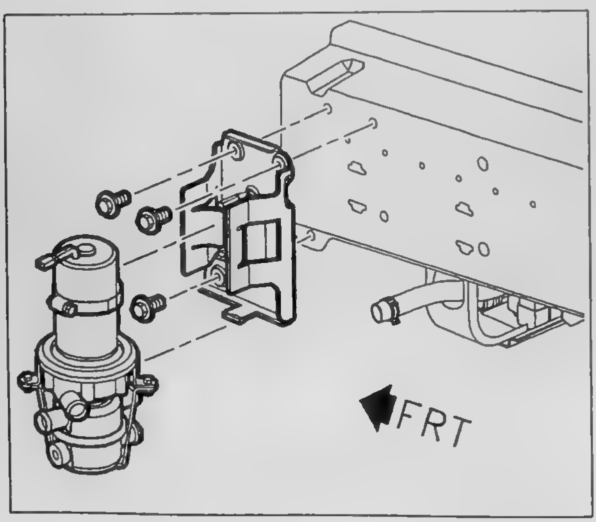
14. Remove water pump buffer connector from water pump bracket.

    Disconnect water pump buffer electrical connector.



PSMPEN67087AA

15. Disconnect water pump to water pump bracket band clamp. Remove water pump from bracket.



PSMPEN67029AA

16. Remove water pump bracket bolts. Remove bracket from front mid-rail.

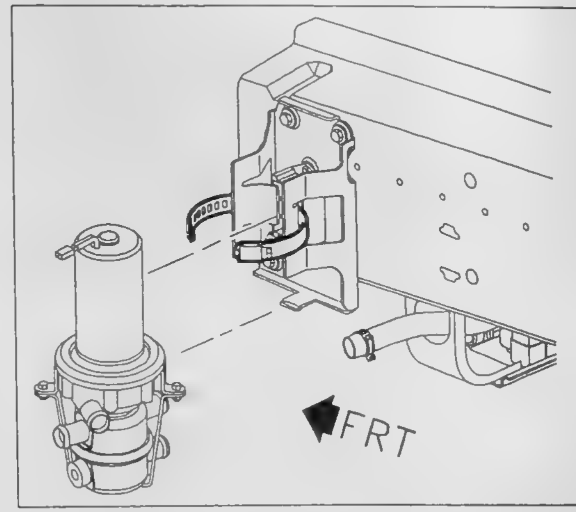
INSTALLATION

1. Align water pump bracket to front mid-rail install bolts.

Torque: **10 N•m (89 in–lbs)**

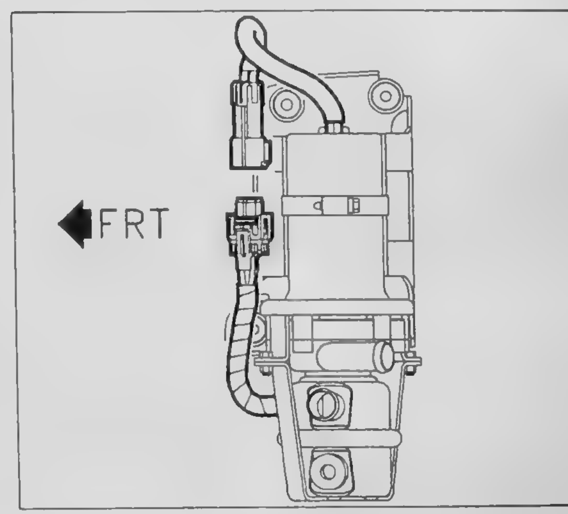
2. Install water pump into water pump bracket.
3. Install water pump bracket band clamp around water pump and tighten.

Torque: **2.5 N•m (22 in–lbs)**



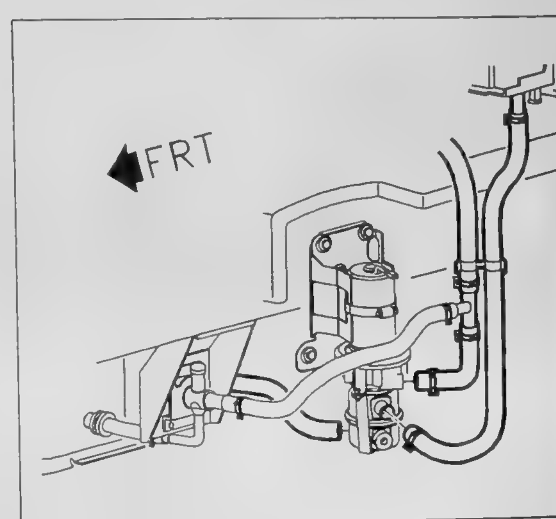
PSMPEN67087A

4. Connect water pump buffer electrical connector, install connector rose bud into water pump bracket.

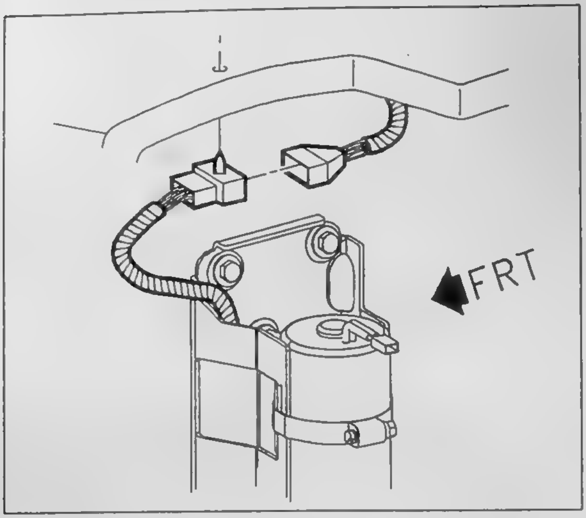


PSMPEN67323

5. Install water pump outlet hose to water pump manifold. Position clamp tangs at 6 o'clock.
6. Install heater outlet hose to water pump manifold. Position clamp tangs at 6 o'clock.
7. Install coolant recovery expansion tank outlet hose to water pump manifold. Position clamp tangs at 4 o'clock.
8. Install radiator outlet hose to water pump manifold. Position clamp tangs to 4 o'clock.

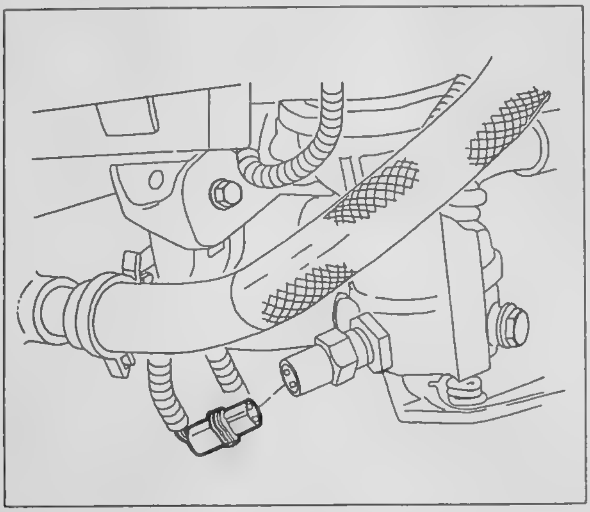


PSMPEN669



PSMPEN66842AA

9. Connect water pump motor electrical connector.



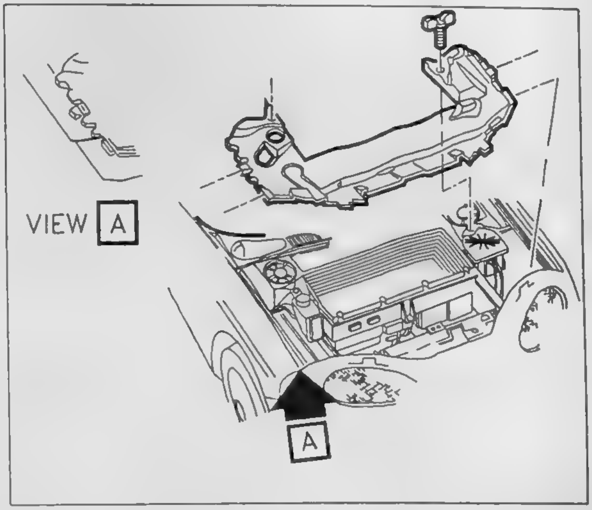
PSMPEN66810AA

10. Connect temperature sensor electrical connector.
11. Fill coolant system, follow "Coolant Fill" procedure found in this service manual.
12. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

TEMPERATURE SENSOR

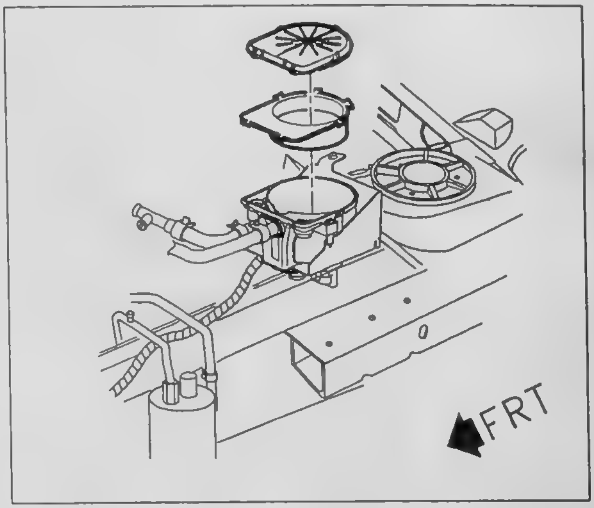
REMOVAL

1. Remove engine compartment sight shield.



PSMGEP65869AC

2. Remove the expansion tank cover.
3. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
4. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



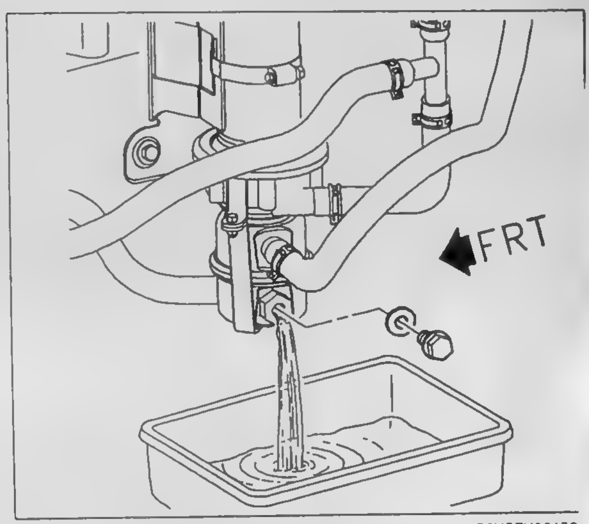
PSMPEN66720AA

5. Position drain pan under coolant pump manifold.

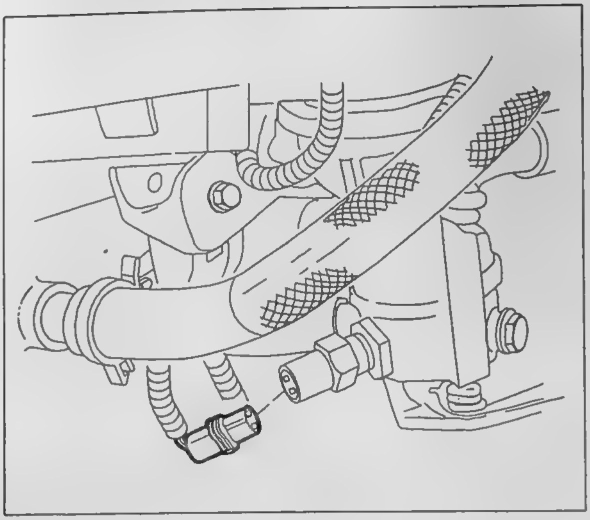
IMPORTANT: A two gallon container will be required to hold the coolant.

6. Remove the drain plug and gasket from the coolant pump manifold allowing the coolant to flow from the main path, into container.
7. After coolant has drained from the main path reinstall water pump manifold drain plug and gasket.

Torque: 11 N•m (in–lbs)

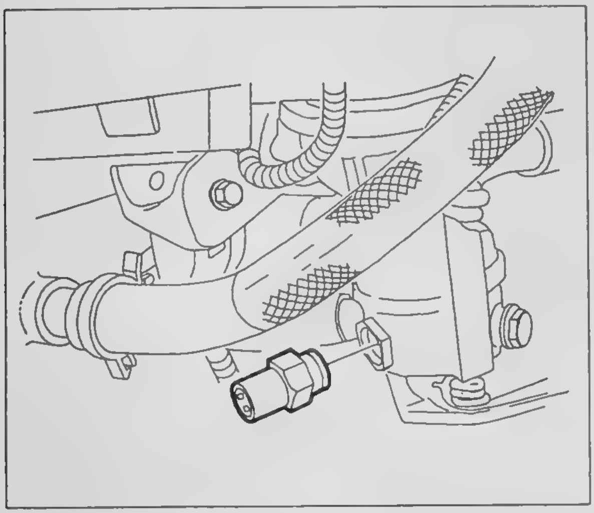


PSMPEN66458



PSMPEN66810AA

8. Disconnect temperature sensor electrical connector.



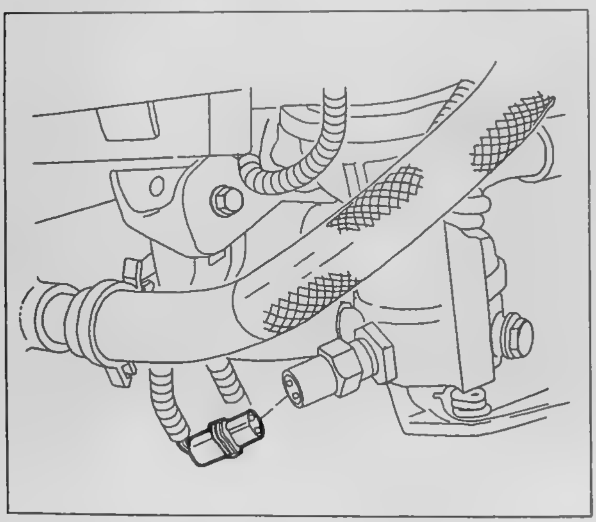
PSMPEN67018AA

9. Remove temperature sensor from water pump manifold, use an open end wrench to back up temperature sensor fitting on the water pump manifold.

INSTALLATION

1. Install temperature sensor into water pump manifold, use an open end wrench to back up temperature sensor fitting on the water pump manifold.

Torque: 12 N•m (106 in−lbs)

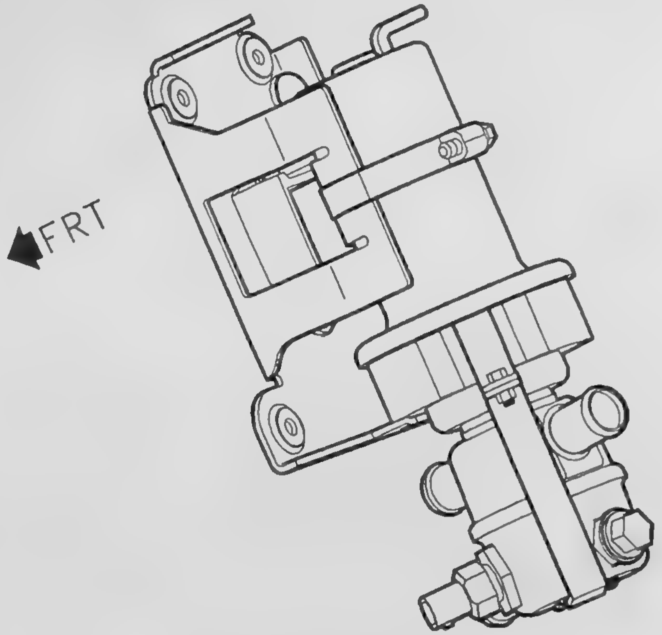


PSMPEN66810AA

2. Connect temperature sensor electrical connector.
3. Fill coolant system, follow "Coolant Fill" procedure found in this section.
4. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

GENERAL DESCRIPTION

WATER PUMP ASSEMBLY



PSMPEN66996AA

The water pump assembly consists of three major components, the electric water pump motor, the water pump and the water pump manifold.

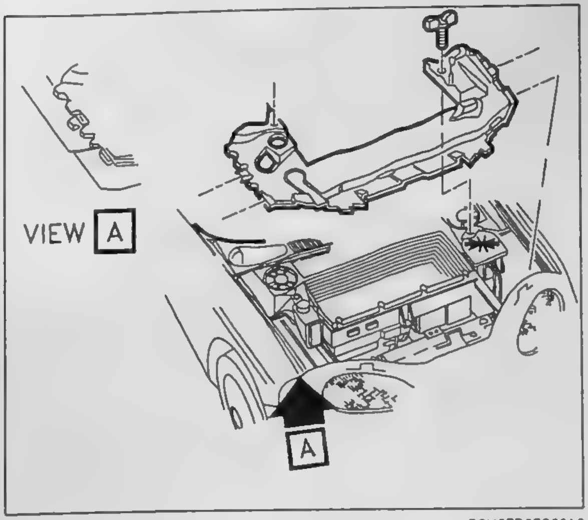
The electric water pump motor is a 12 volt pulse width modulated dc motor that is controlled by the heat pump ventilation system/thermal control module (HTCM), based on coolant temperature sensor readings from the power electronics bay (PEB), drive unit, water pump manifold and battery pack module (BPM) requests. Pulse width modulation allow the HTCM to run the water pump motor from 5 volts to 14 volts, this controls the coolant flow rate and maintains the optimal coolant temperature eliminating the need for a thermostat with in the coolant system. Pulse width modulation also allows the electric water pump to soft start the motor, which reduces current surge and increases motor life.

The water pump is driven by the electric water pump motor and distributes the coolant through the cooling system. The water pump is a compact close tolerance impeller type pump.

The water pump manifold has several functions, zero pressure loss return for radiator and heater, vents to expansion tank to prevent cavitation, houses a coolant temperature sensor, two way feed to coolant vessel which maintains the coolant level during the fill procedure, venting and pressure relief. The water pump manifold drain plug is the main drain path for the coolant system drain procedure.

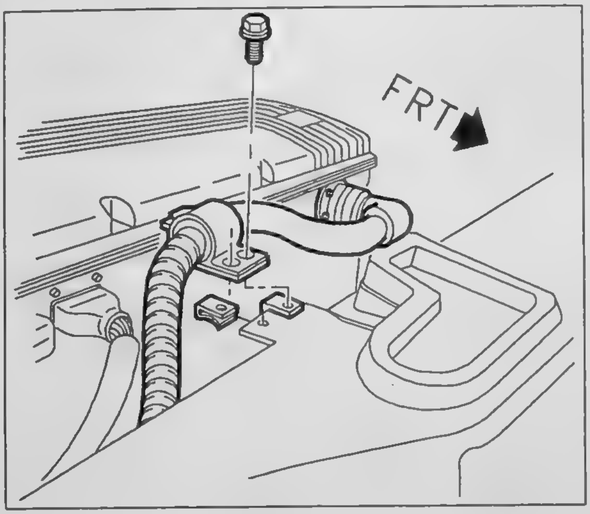
RADIATOR UPPER MOUNTING CLOSE-OUT PANEL ASSEMBLY

REMOVAL



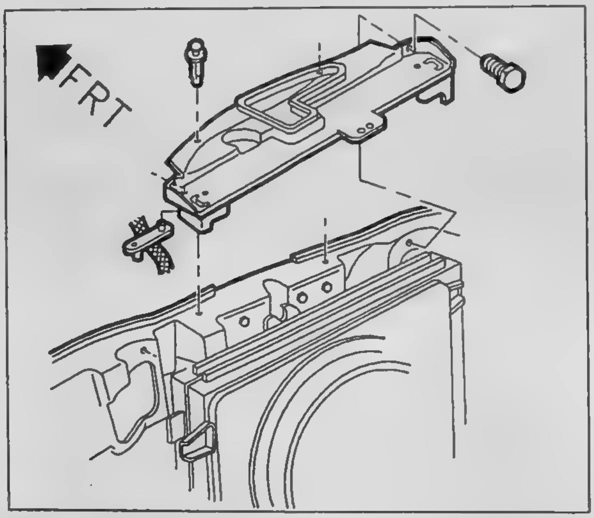
PSMGEP65869AC

1. Remove engine compartment sight shield.



PSMPEN66657AA

2. Remove screws from radiator upper mounting close-out panel that retain charger receptacle cable.



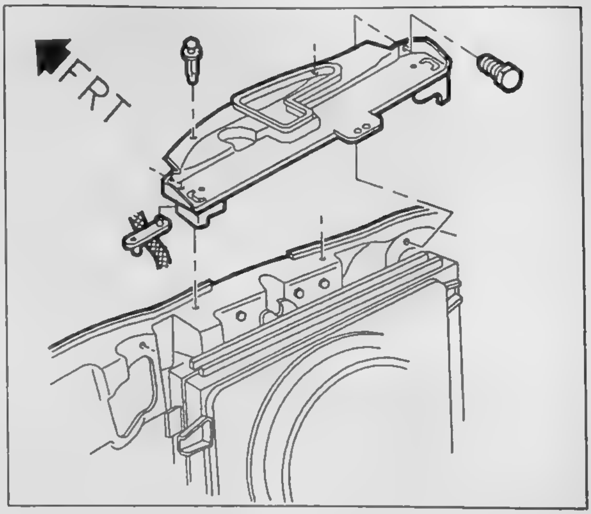
PSMPEN66553AA

3. Remove fasteners from radiator upper mounting close-out panel.
4. Disconnect charger receptacle vent hose retainer from radiator upper mounting close-out panel.
5. Remove close-out panel from vehicle.

INSTALLATION

1. Connect charger receptacle vent hose retainer to radiator upper mounting close-out panel.
2. Install radiator upper mounting close-out panel.

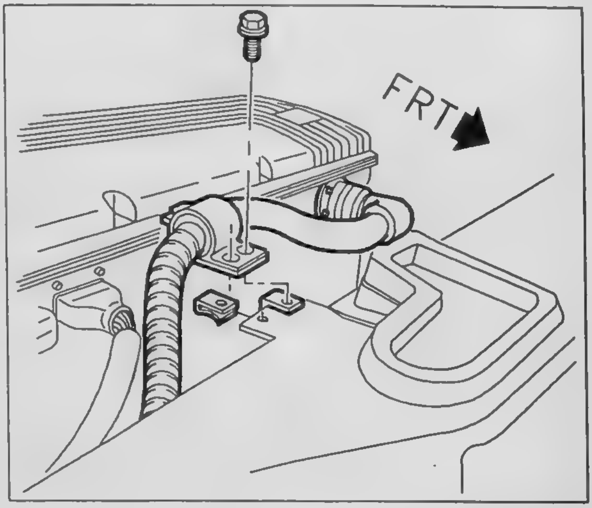
Torque: 10 N•m (89 in–lbs)



PSMPEN66553AA

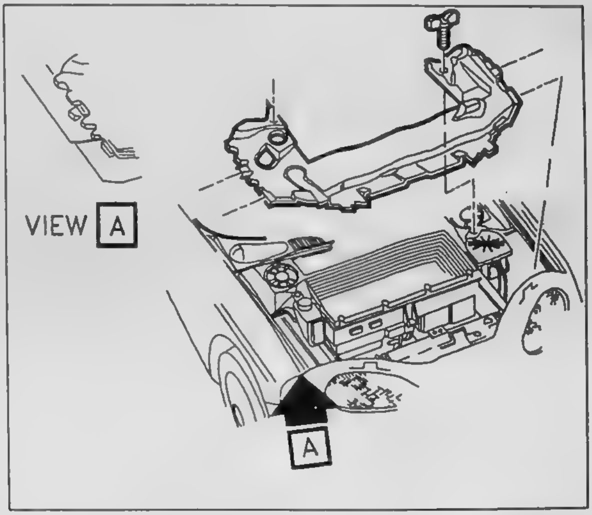
3. Install charger receptacle cable retainer to radiator upper mounting close-out panel. Tighten fasteners.

Torque: 10 N•m (89 in–lbs)

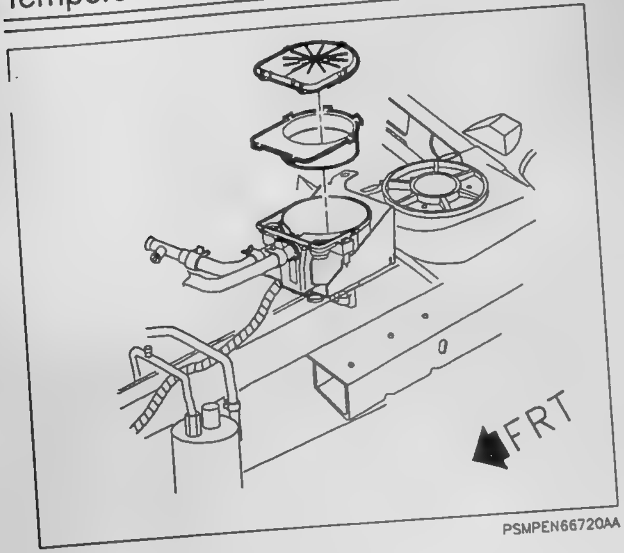


PSMPEN66657AA

4. Install engine compartment sight shield.



PSMGEP65869AC

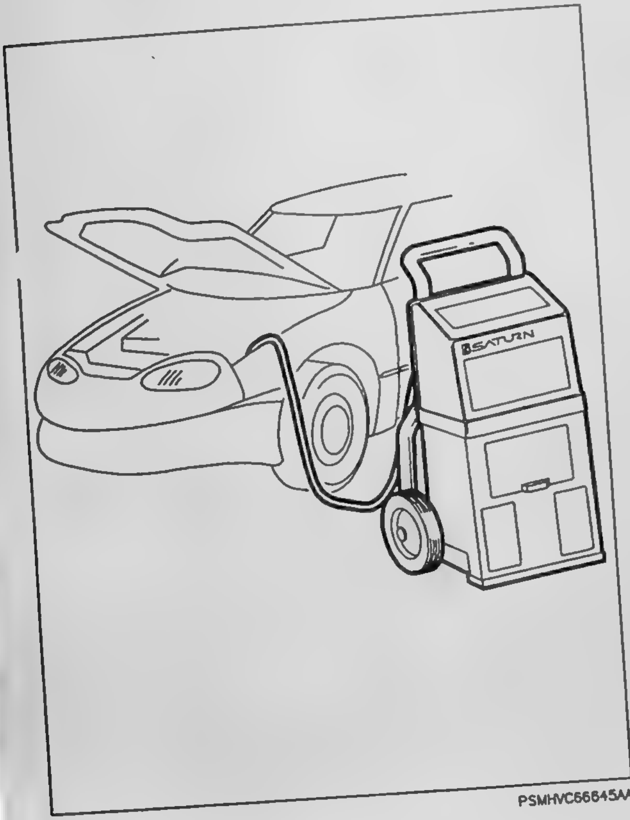


PSMPEN66720AA

CONDENSER RADIATOR FAN MODULE ASSEMBLY (CRFM)

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Disable high voltage. (Refer to "High Voltage Disable" procedure in this manual.)
3. Remove expansion tank cover.



PSMHVC66645AA

4. Recover R−134a refrigerant using an approved refrigerant recovery system.

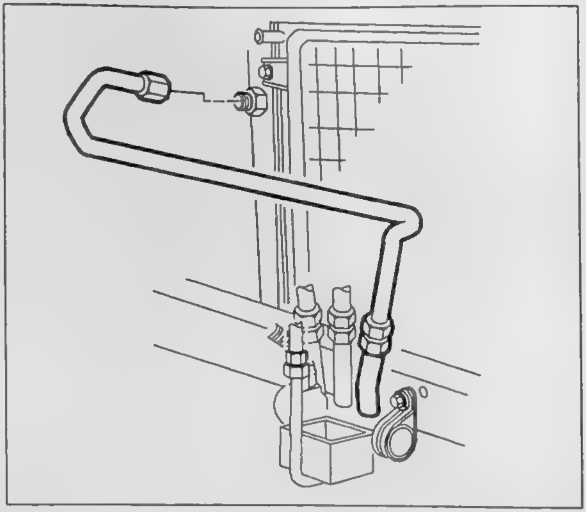
   Follow the manufacturers operating instruction for system being used.

NOTICE: The air conditioning refrigerant and recycling station must meet UL standards for moisture and contamination removal. Recovery system which cannot meet these standards are not approved for warranty repairs. Reuse of moisture or particulate contaminated refrigerant will result in premature compressor and other component failure.

Always check heat pump system for pressure with a manifold gauge set to determine if refrigerant is present in the system. Performing recovery on an heat pump system which is open to atmosphere as a result of a leak, would allow the recovery station to pull only air into the tank.

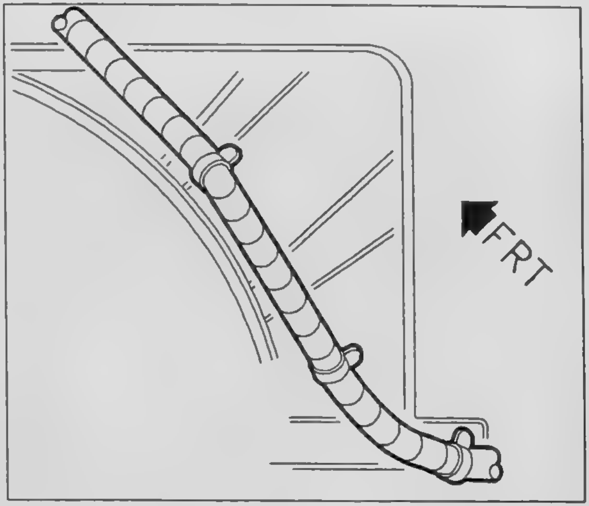
NOTICE: Failure to check for residual oil from the previous recovery can result in adding extra oil to the vehicle currently being serviced. This will also result in insufficient oil in the system previously work on and could possible contribute to premature compressor failure.

5. Disconnect condenser tube from upper condenser fitting.



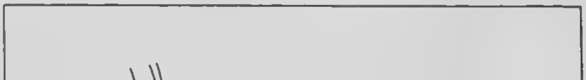
PSMPEN66554AA

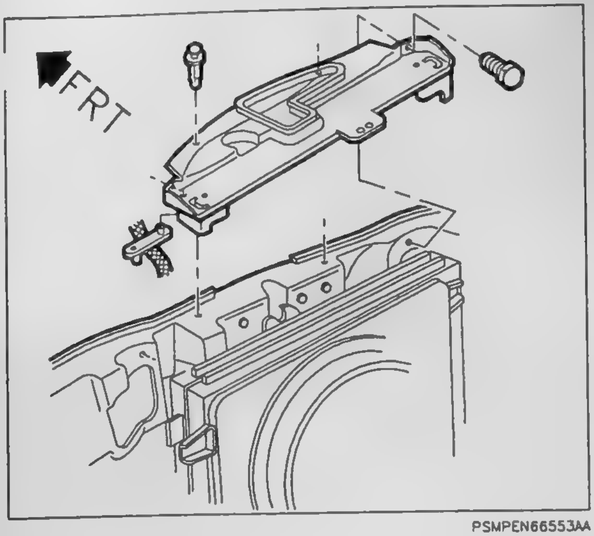
6. Disconnect the charger receptacle cable rose bud retainers from fan shroud.



PSMPEN66656AA

7. Disconnect fan motor buffer electrical connector at right hand mid-rail.



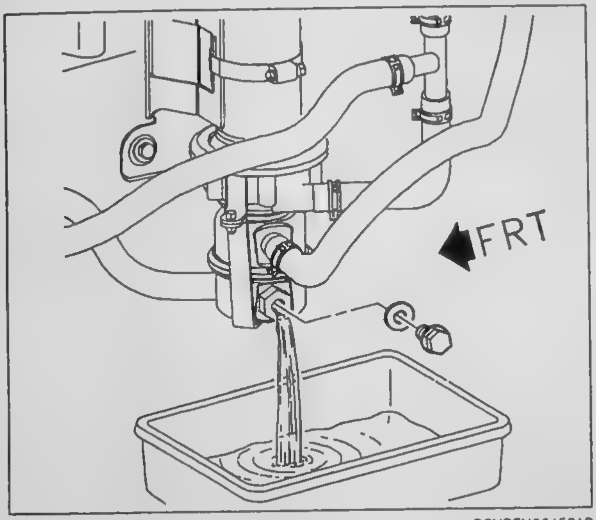


PSMPEN66553AA

8. Remove fasteners from the CRFM upper mounting close out panel. Disconnect charger receptacle vent hose retainer from close out panel. Position panel over right side strut tower area.

9. Raise vehicle on hoist.

10. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



PSMPEN66458AB

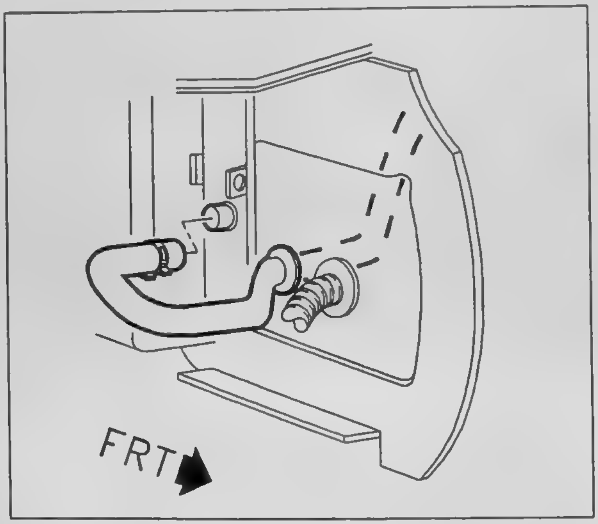
11. Position drain pan under coolant pump manifold.

IMPORTANT: A two gallon container will be required to hold the coolant.

a. Remove the drain plug and gasket from the coolant pump manifold allowing the coolant to flow from the main path, into container.

b. After coolant has drained from the main path reinstall water pump manifold drain plug and gasket.

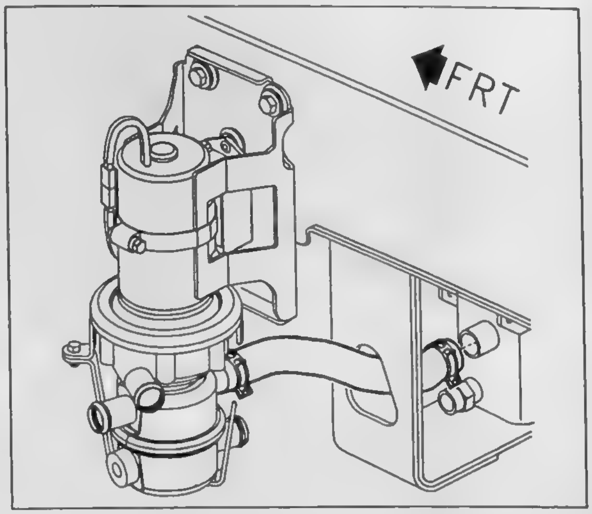
Torque: **11 N•m (97 in–lbs)**



PSMPEN66652AA

12. Remove charger receptacle outlet hose from the radiator.

13. Remove radiator outlet hose from radiator.

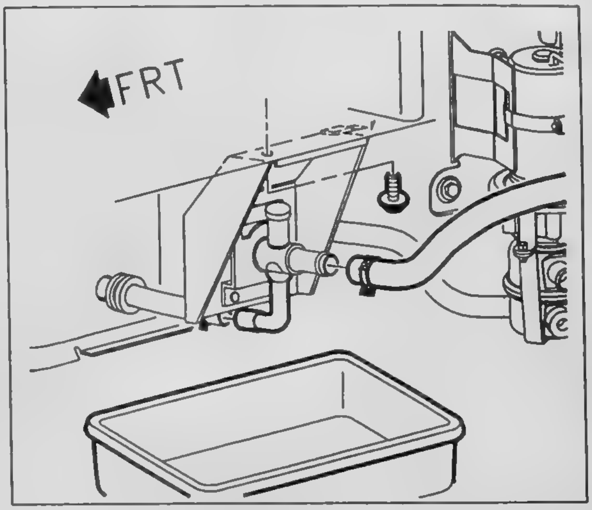


PSMPEN66465AB

14. Remove the charger receptacle inlet hose from charger receptacle coolant valve.

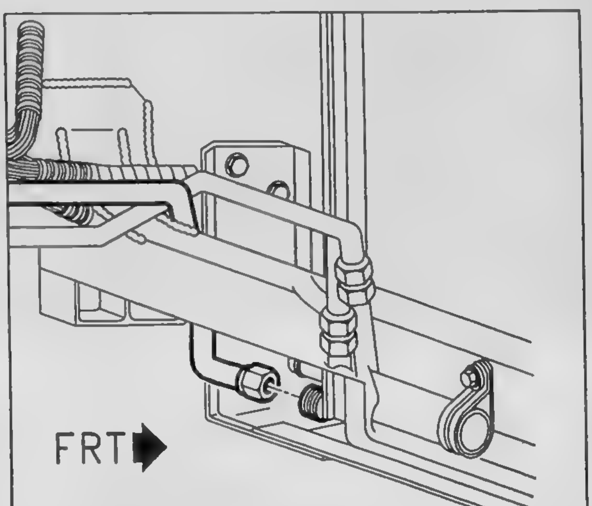
IMPORTANT: Coolant will flow from both the hose and the valve fitting.

a. Remove fastener retaining charger receptacle coolant valve, and position valve out of way.

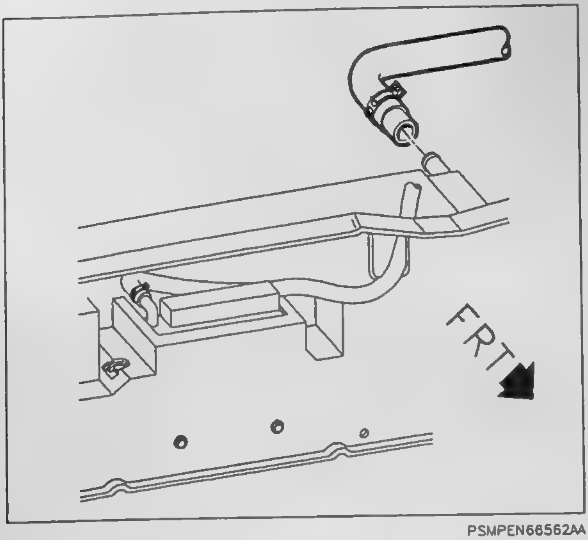


PSMPEN66928AA

15. Disconnect the evaporator tube from condenser.
16. Lower vehicle on hoist.

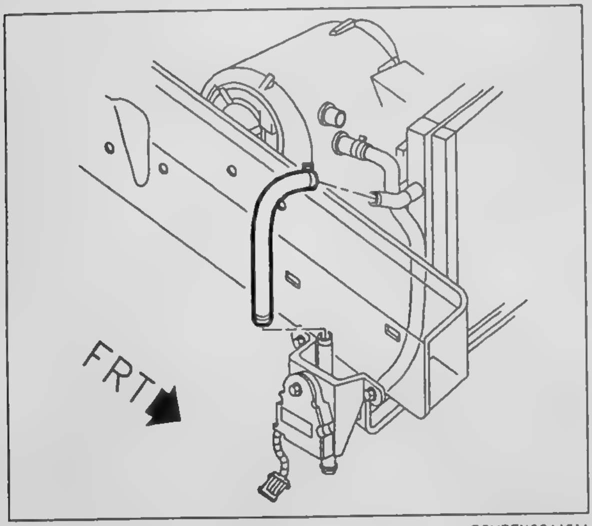


PSMPEN66398AB



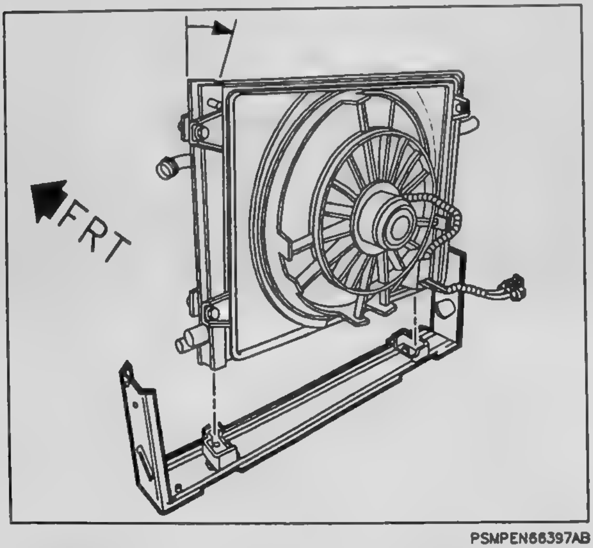
PSMPEN66562AA

17. Remove radiator vent hose from radiator.



PSMPEN66446AA

18. Remove radiator inlet hose from radiator.

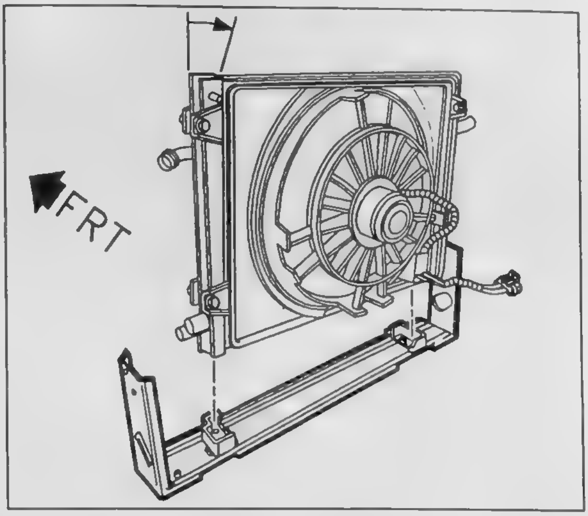


PSMPEN66397AB

19. Tilt the top of the CRFM assembly rearward and lift out of CRFM lower mounting support.

INSTALLATION

1. Tilt the top of the CRFM assembly rearward, align radiator and condenser to CRFM lower mounting support insulators.
2. Raise vehicle on hoist.

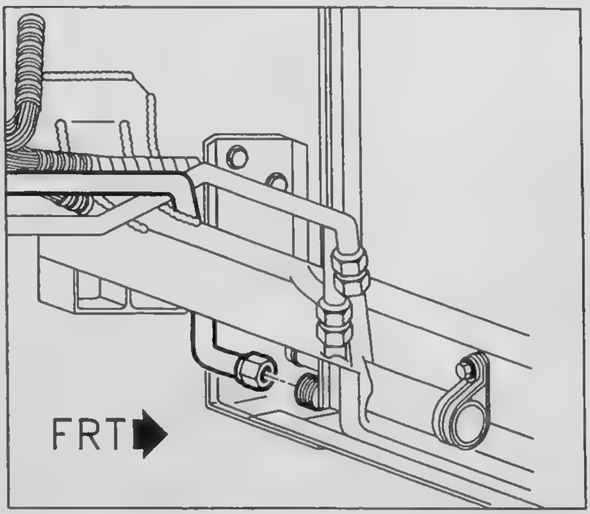


PSMPEN66397AB

NOTICE: Use only R−12 refrigerant oil (mineral) to lubricate O-rings. Use of R−134a (PAG) oil will cause premature corrosion of fitting joints.

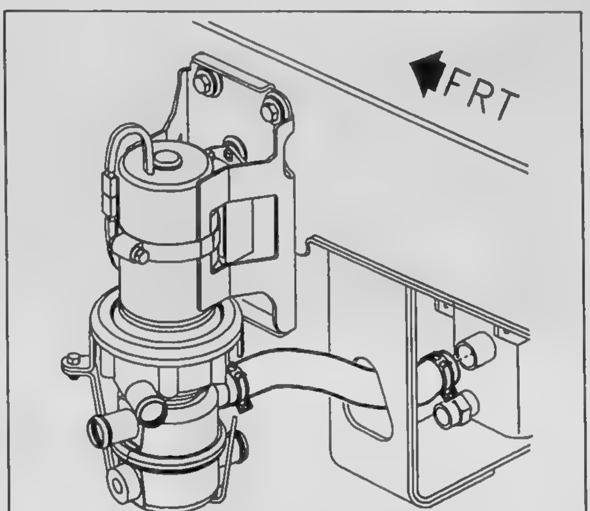
3. Lubricate with R−12 mineral oil and install new O-ring on lower A/C condensor tube.
4. Install lower A/C tube line connection to condensor.

Torque: 20 N•m (15 ft−lbs)



PSMPEN66398AB

5. Install radiator outlet hose to radiator. Position clamp tangs to 4 o'clock.



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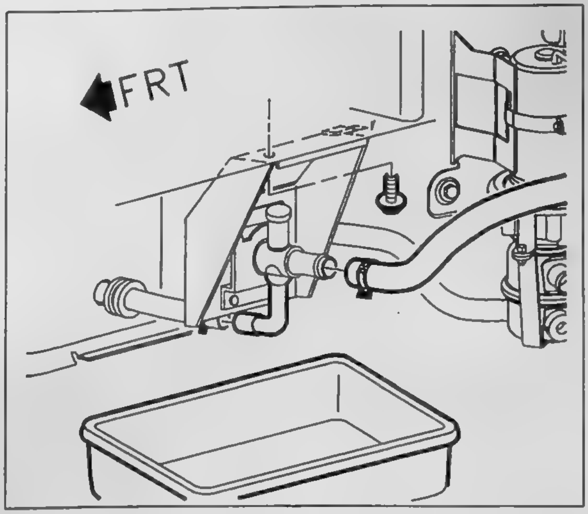
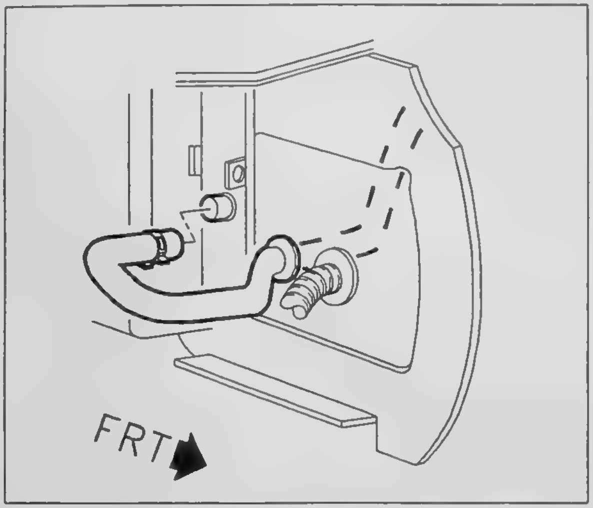


PSMPEN66928AA

6. Install the charger receptacle coolant valve.

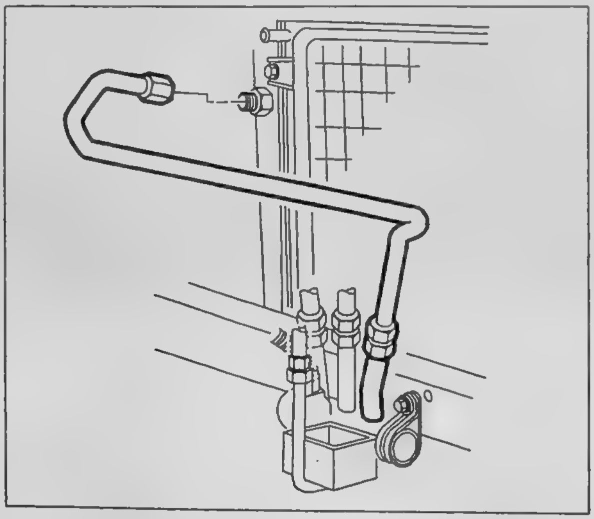
Torque: **10 N•m (89 in–lbs)**

7. Install charger receptacle inlet hose to charger receptacle coolant valve. Position clamp tangs to 6 o'clock.



PSMPEN66652AA

8. Install charger receptacle outlet hose to the radiator. Position clamp tangs to 4 o'clock.
9. Lower vehicle on hoist.



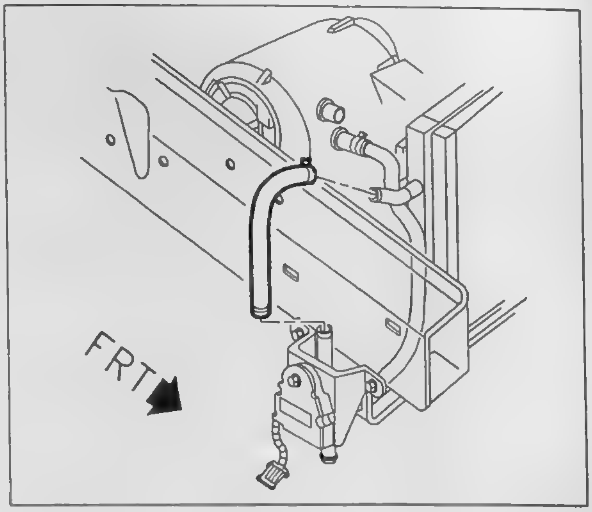
PSMPEN66554AA

NOTICE: **Use only R–12 refrigerant oil (mineral) to lubricate O-rings. Use of R–134a (PAG) oil will cause premature corrosion of fitting joints.**

10. Lubricate with R–12 mineral oil and install new O-ring on upper A/C condensor tube.
11. Install upper A/C tube line connection to condensor.

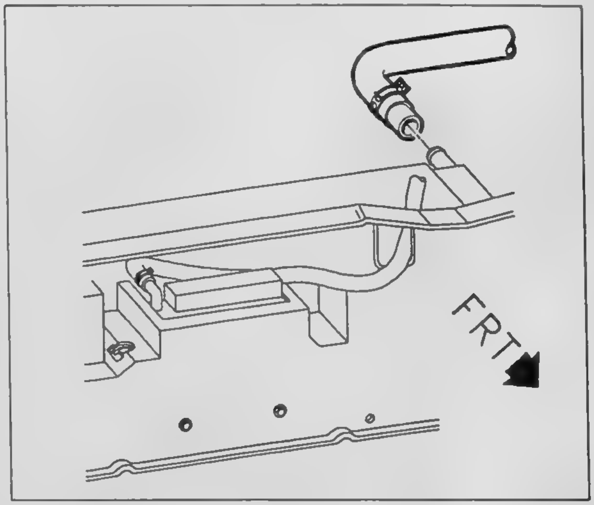
Torque: **20 N•m (15 ft–lbs)**

12. Install radiator inlet hose to radiator. Position clamp tangs to 12 o'clock.



PSMPEN66446AA

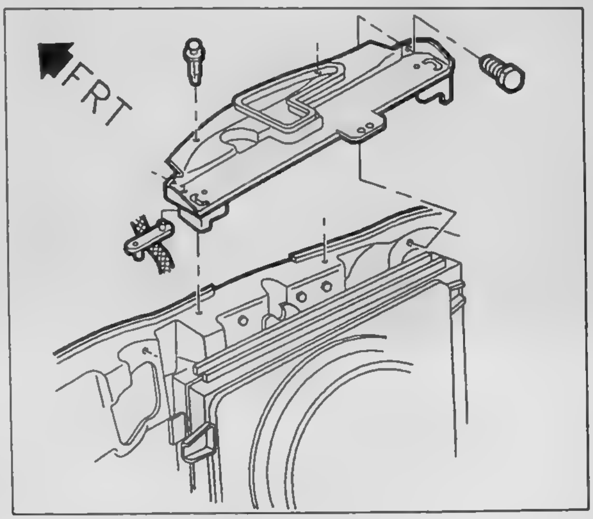
13. Install radiator vent hose to radiator. Position clamp tangs to 12 o'clock.



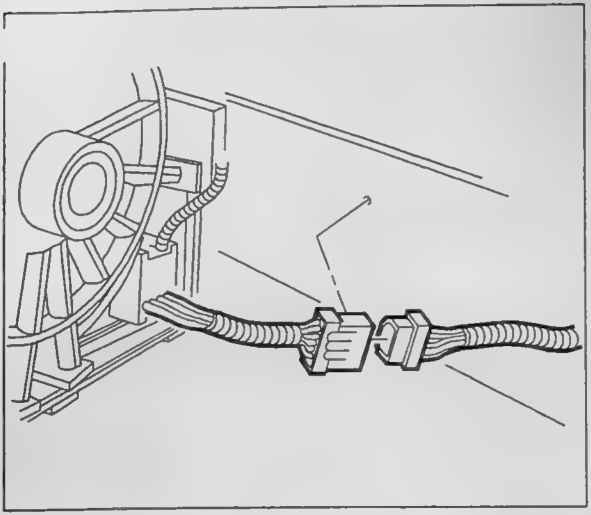
PSMPEN66562AA

14. Connect charger receptacle vent hose retainer to radiator upper mounting close out panel.
15. Install radiator upper mounting close out panel.

Torque: **10 N•m (89 in–lbs)**

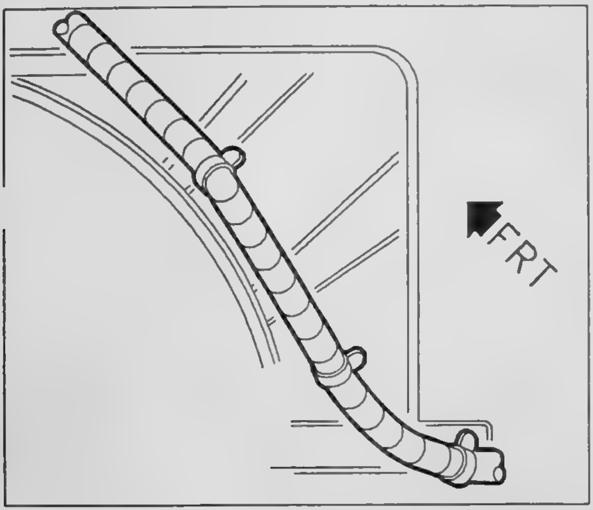


PSMPEN66553AA



PSMPEN66396AA

16. Connect fan motor buffer electrical connector at right hand mid-rail.



PSMPEN66656AA

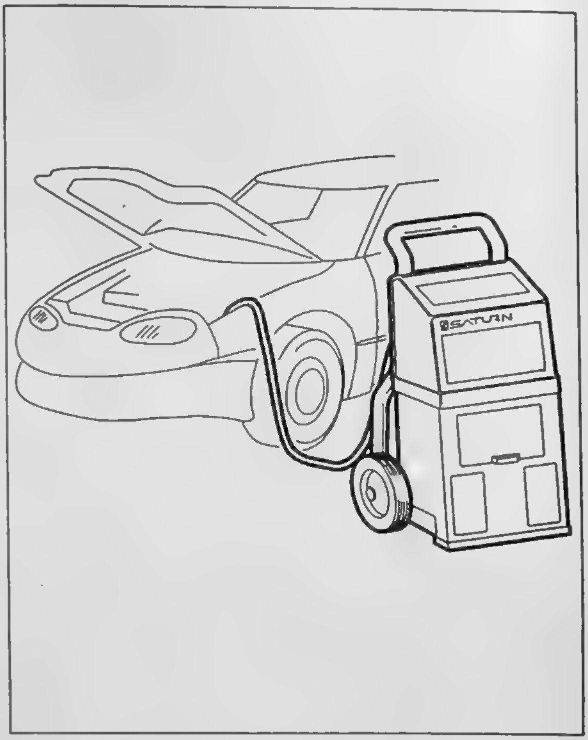
17. Connect charger receptacle cable rose bud retainers to fan shroud.
18. Enable high voltage. (Refer to "Enable High Voltage" procedure in this manual.)

19. Evacuate heat pump system. Install new Electric Vehicle approved service replacement heat pump schrader valves prior to evacuating system. Even though a schrader valve may look the same, it is extremely important that only recommended service replacement heat pump schrader valves be used or leakage of refrigerant will occur.

20. The refrigerant system must be evacuated using an air conditioning refrigerant recovery and recycling system. Follow the manufacturers operating instruction for system being used.

21. Allow system to evacuate for the predetermined time on the refrigerant recovery and recycling system. Note vacuum gauge readings.

22. Watch low side gauge for vacuum loss (one to three minutes). If loss is less than 3.38 kPa (1 in. Hg) from level recorded in Step 21, proceed to charging the heat pump system.



PSMHVC66645AA

23. If vacuum loss is greater than 3.38 kPa (1 in. Hg) from level recorded in Step 21, charge with 0.23 kg (1/2 lb.) R−134a. Leak test, repair leaks and re-test.

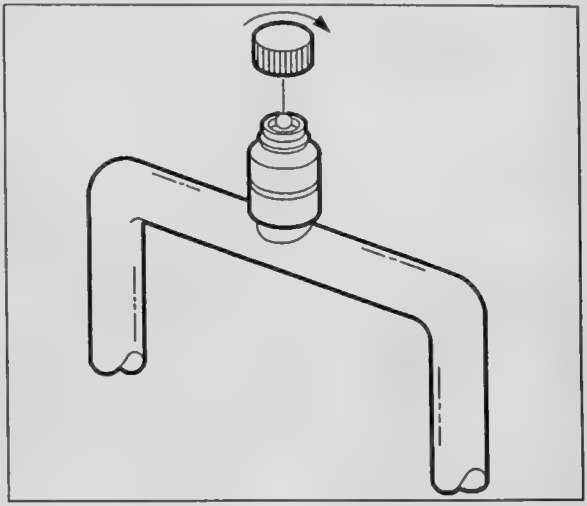
24. The refrigerant system must be charged using a R−134a air conditioning refrigerant charging system. Follow the manufacturers operating instructions for system being used with the following exceptions.

25. Do not connect low pressure line to heat pump system.

26. Keep low pressure valve on the charging station closed at all times.

27. Perform the entire charge procedure through the high-pressure service fitting on the discharge pipe.

28. Charge the heat pump system with 0.91 kg (2.0 lbs.) of R−134a refrigerant.



PSMHVC66646AB

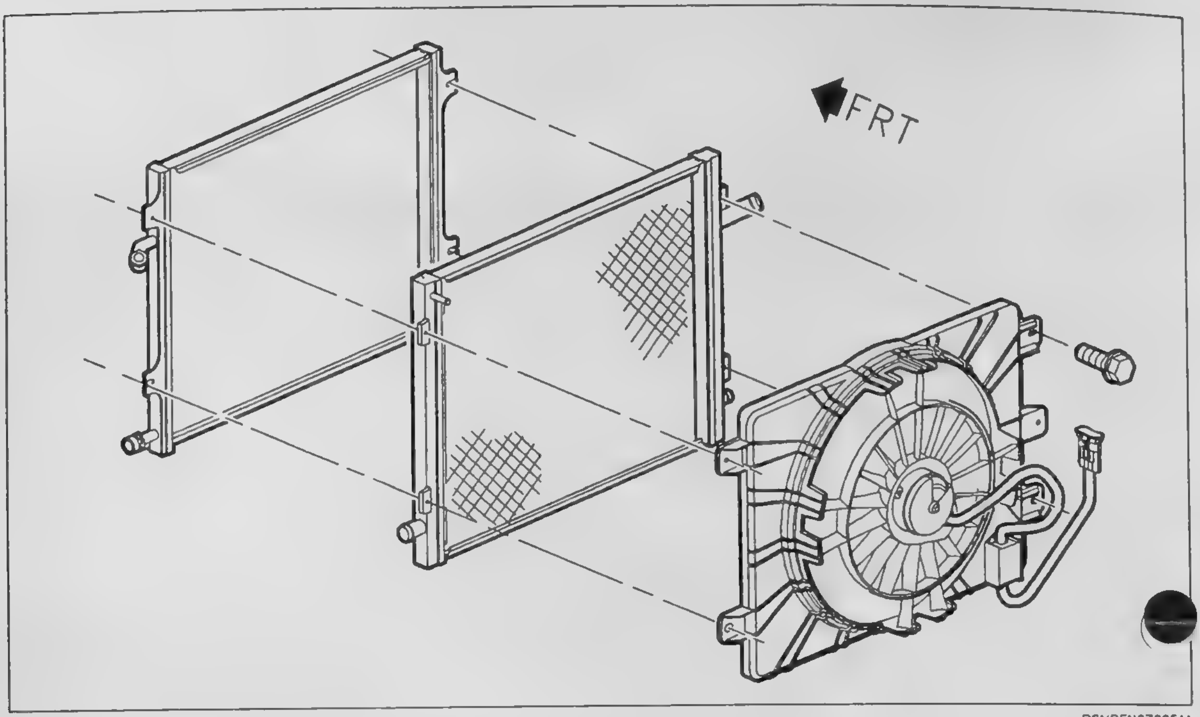
IMPORTANT: Make sure there is an O-ring seal inside of caps before installation because the cap is the primary seal for heat pump system service fittings. Failure to tighten cap will result in refrigerant leakage.

29. Fill coolant system as outlined in "Fill Coolant System" procedure found in this section.

30. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

GENERAL DESCRIPTION

CONDENSER, RADIATOR, FAN MODULE ASSEMBLY (CRFM)



PSMPEN67085AA

The condenser assembly in front of the radiator is made up of coils which carry refrigerant, and cooling fins to provide rapid transfer of heat during heating and A/C modes. The condenser is made of aluminum tubes on which are mounted aluminum fins. The fins provide the cooling or heating capacity of the condenser. The fins should be kept clean and less than 20 percent of the fins should be bent or otherwise damaged.

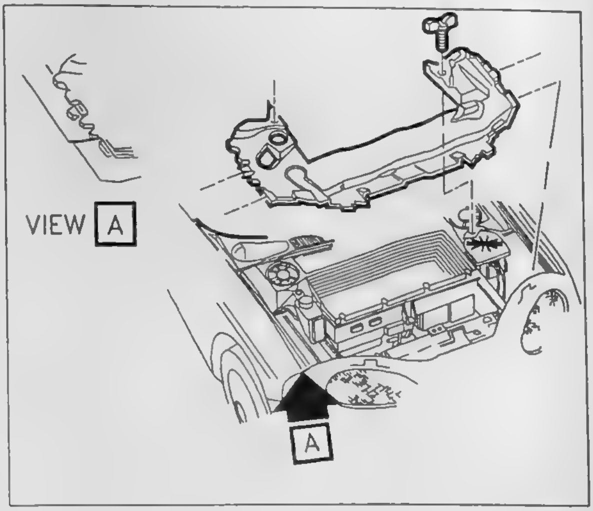
The radiator is a cross-flow type with the tanks located on the right and left of the core.

The coolant fan is 10 mm (5 in.) long with seven unequally spaced blades to provide air flow through the radiator/condenser. The fan is driven by an electric motor which is attached to the radiator shroud. The electric fan motor is controlled by the HTCM based on coolant temperature and A/C request. The voltage to the electric fan motor is pulse width modulated to reduce current surge and increase motor life.

COOLANT RECOVERY CHECK VALVE

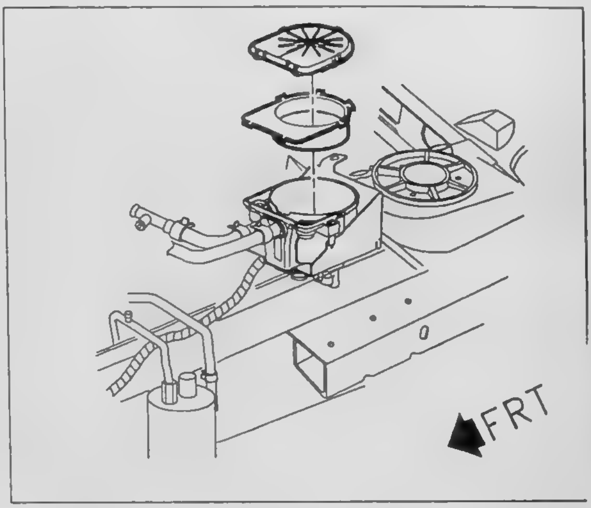
REMOVAL

1. Remove engine compartment sight shield.



PSMGEP65869AC

2. Remove the expansion tank cover.
3. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
4. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



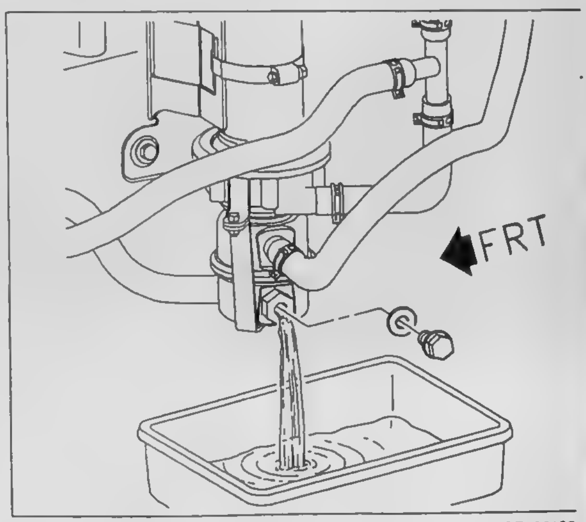
PSMPEN66720A

5. Position drain pan under water pump manifold.

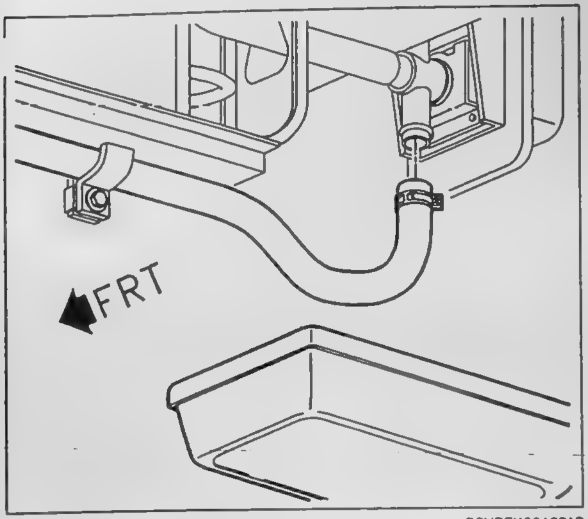
IMPORTANT: A two gallon container will be required to hold the coolant.

6. Remove the drain plug and gasket from the water pump manifold allowing the coolant to flow from the main path.
7. After coolant has drained from the main path reinstall water pump manifold drain plug and gasket.

Torque: 11 N•m (97 in–lbs)



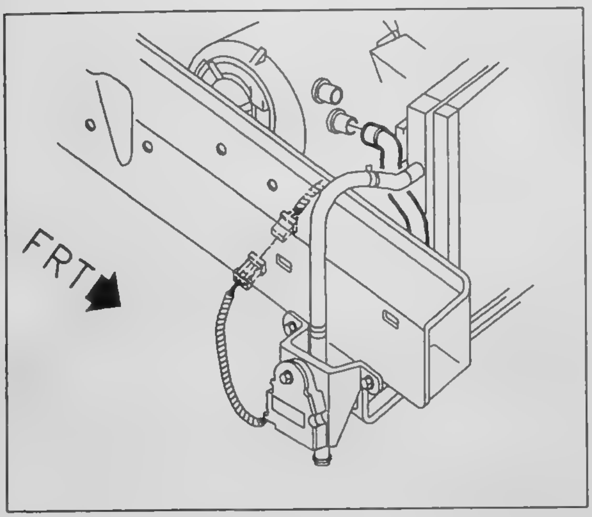
PSMPEN66458



PSMPEN66460AB

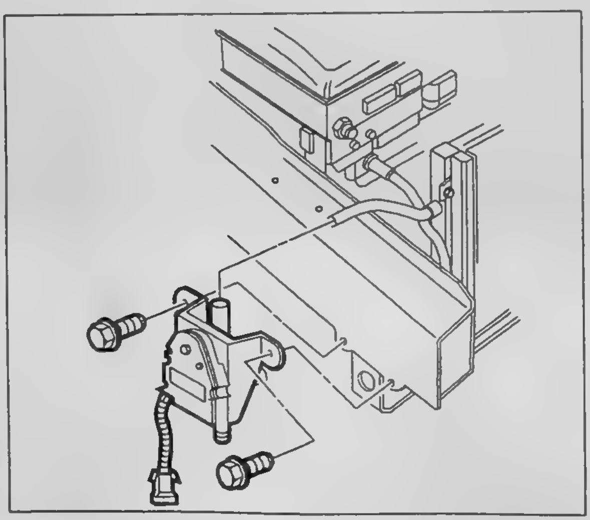
8. Position drain pan under right hand mid-rail under the coolant recovery check valve.
9. Remove lower clamp and hose from coolant recovery check valve, draining coolant from the heater core and the valve.

IMPORTANT: Coolant will flow from both the hose and the valve fitting.



PSMPEN66841AA

10. Disconnect coolant recovery check valve electrical connector.



PSMPEN66343AA

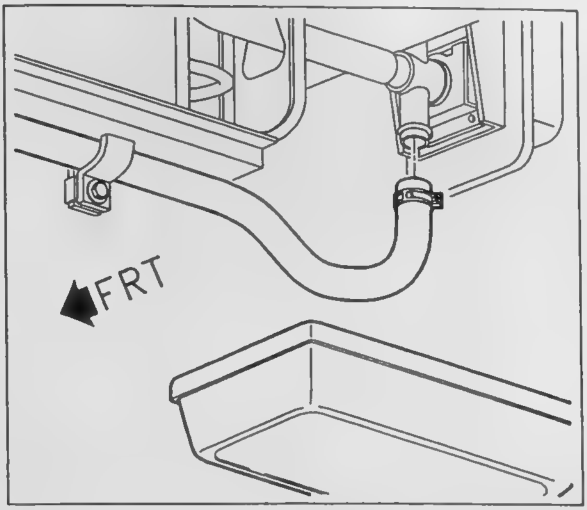
11. Remove coolant recovery check valve to right mid-rail bolts.
12. Gently slide the valve away from the mid-rail and remove clamp and hose from the valve.
13. Remove upper clamp and hose from valve.

INSTALLATION

1. Install center hose and clamp that is routed through the radiator support bracket on to coolant recovery check valve. Position clamp tangs at 3 o'clock.
2. Install upper hose and clamp on to coolant recovery check valve. Position clamp tangs at 9 o'clock.
3. Align coolant recovery check valve to right mid-rail, sliding the drive unit outlet hose through the lower radiator support. Install coolant recovery check valve to right mid-rail bolts.

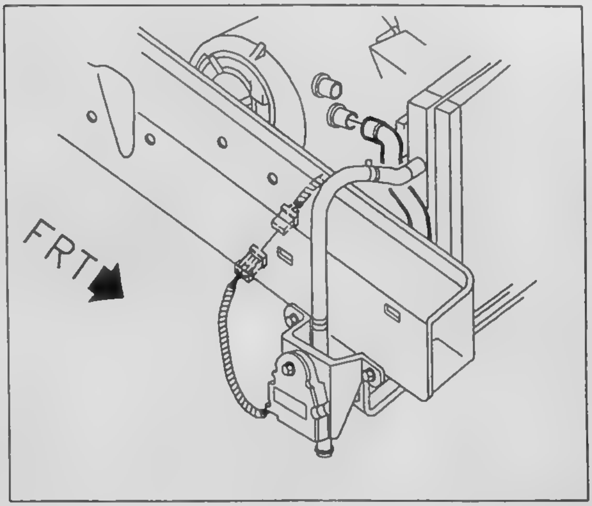
Torque: **10 N•m (89 in–lbs)**

4. Install lower hose and clamp on to coolant recovery check valve. Position clamp tangs at 4 o'clock.



PSMPEN66460AB

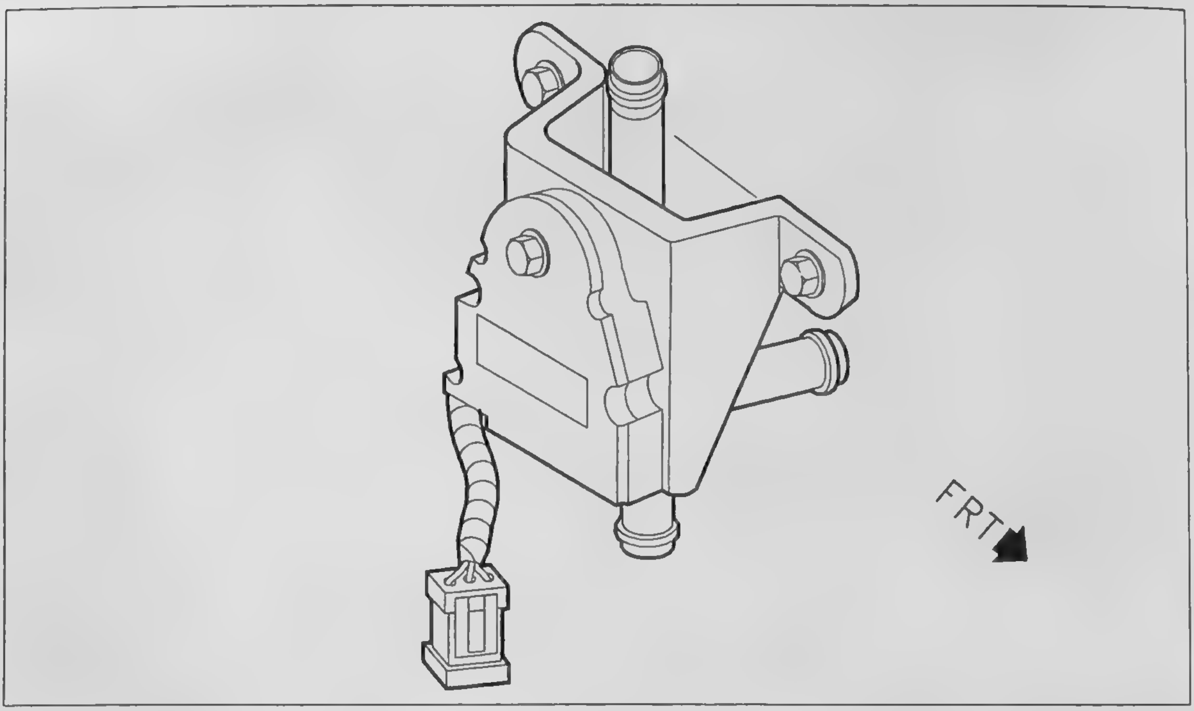
5. Connect valve electrical connector.
6. Fill coolant system, following the "Fill Coolant System" procedure found in this service manual.
7. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



PSMPEN66841AA

GENERAL DESCRIPTION

COOLANT RECOVERY CHECK VALVE



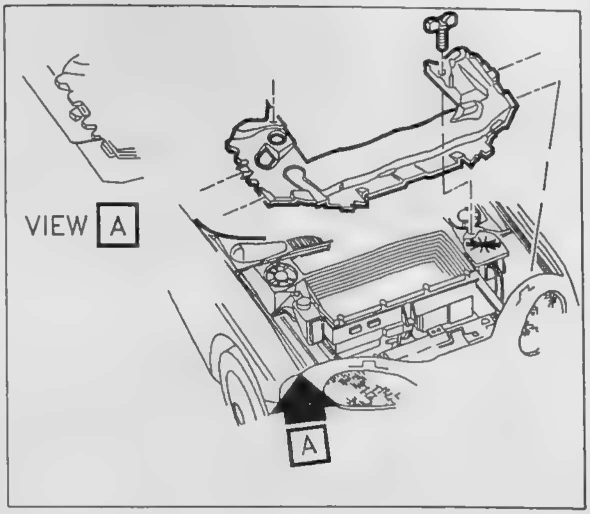
PSMPEN66844AA

The coolant recovery check valve has two major components the mechanical diverter valve and the 12 volt actuator. The valve diverts coolant from the radiator to the heater core when the heat mode is requested. The 12 volt actuator is controlled by the HPVS/thermal control module (HTCM) and uses a 5 volt reference line to monitor position of the actuator and valve. The valve and actuator will default to the radiator mode if the HTCM detects a fault in the system.

DRIVE MOTOR BATTERY CHARGER RECEPTACLE COOLANT CHECK VALVE

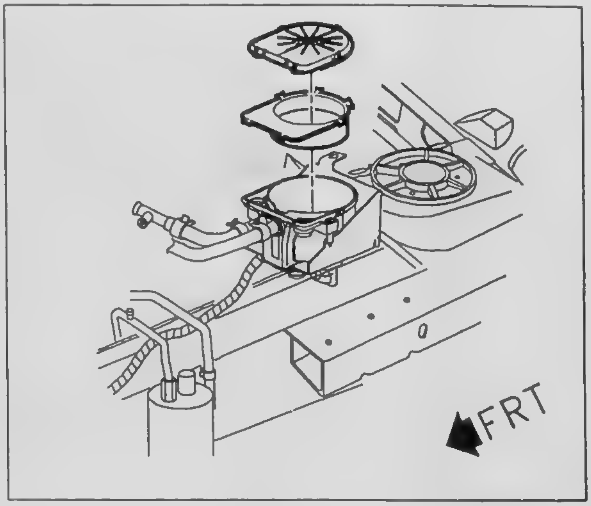
REMOVAL

1. Raise vehicle. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Remove underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)
3. Remove engine compartment sight shield.



PSMCEP65869AC

4. Remove the expansion tank cover.



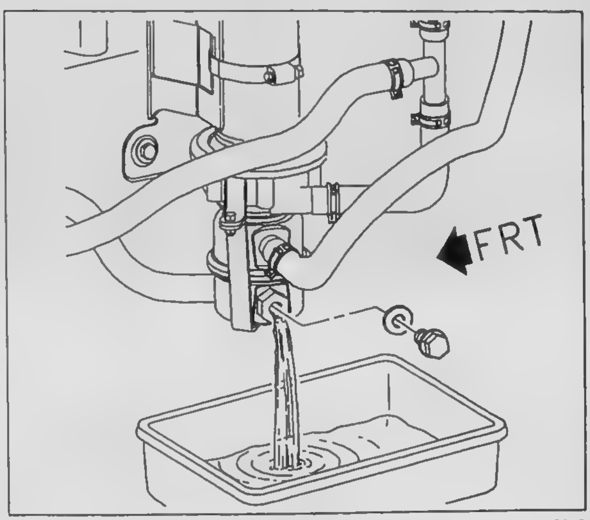
PSMPEN66720AA

5. Position drain pan under water pump manifold.

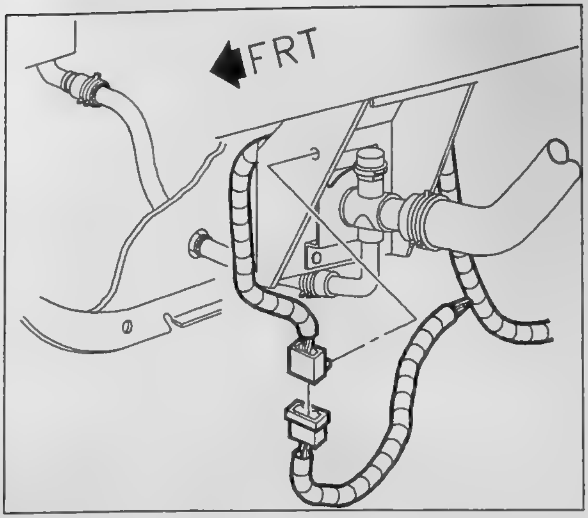
IMPORTANT: A two gallon container will be required to hold the coolant.

6. Remove the drain plug and gasket from the water pump manifold allowing the coolant to flow from the main path.
7. After coolant has drained from the main path reinstall water pump manifold drain plug and gasket.

Torque: 11 N•m (97 in–lbs)

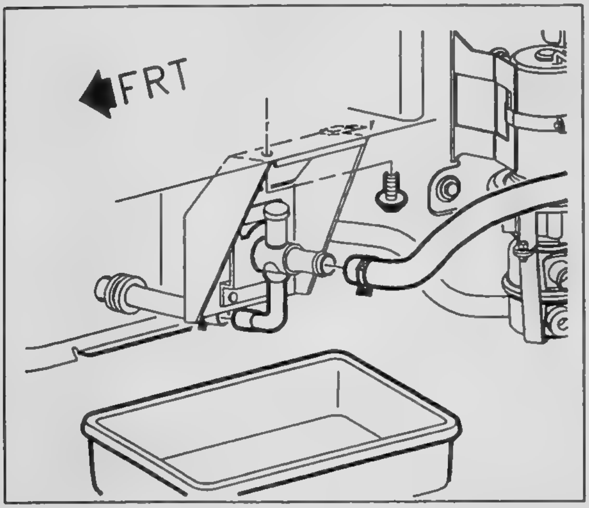


PSMPEN66458AB



PSMPEN66661AA

8. Disconnect charger receptacle valve electrical connector.



PSMPEN66928AA

9. Position drain pan under left mid-rail by the charger receptacle coolant valve.
10. Remove water pump outlet clamp and hose from charger receptacle valve.
11. Remove charger receptacle coolant inlet clamp and hose from valve.

IMPORTANT: Coolant will flow from both the hose and the valve fitting.

12. Remove charger receptacle valve bolt from the bottom side of the left hand mid-rail. Slide valve rearward to disengage valve tab from slot in mid-rail.

INSTALLATION

1. Insert charger receptacle valve tab into slot in left hand mid-rail, slide valve forward and install valve bolt.

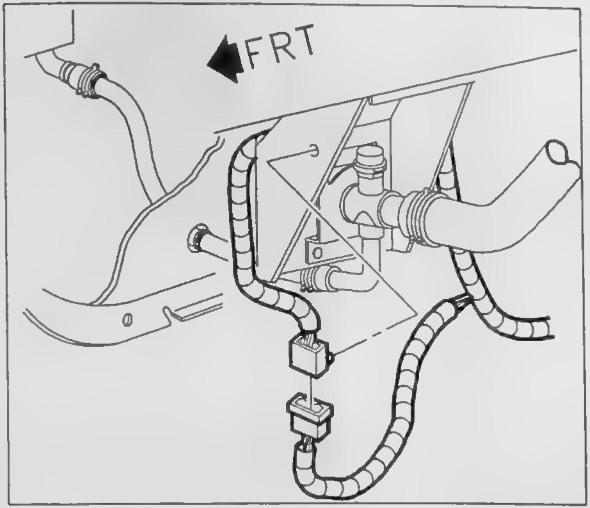
Torque: **10 N•m (89 in–lbs)**

2. Install water pump outlet hose and clamp on to charger receptacle valve. Position clamp tangs to 6 o'clock.
3. Install charger receptacle coolant inlet hose and clamp on to charger receptacle valve. Position clamp tangs to 6 o'clock.

4. Connect charger receptacle valve electrical connector.

5. Fill coolant system, following the "Fill Coolant System" procedure found in this service manual.

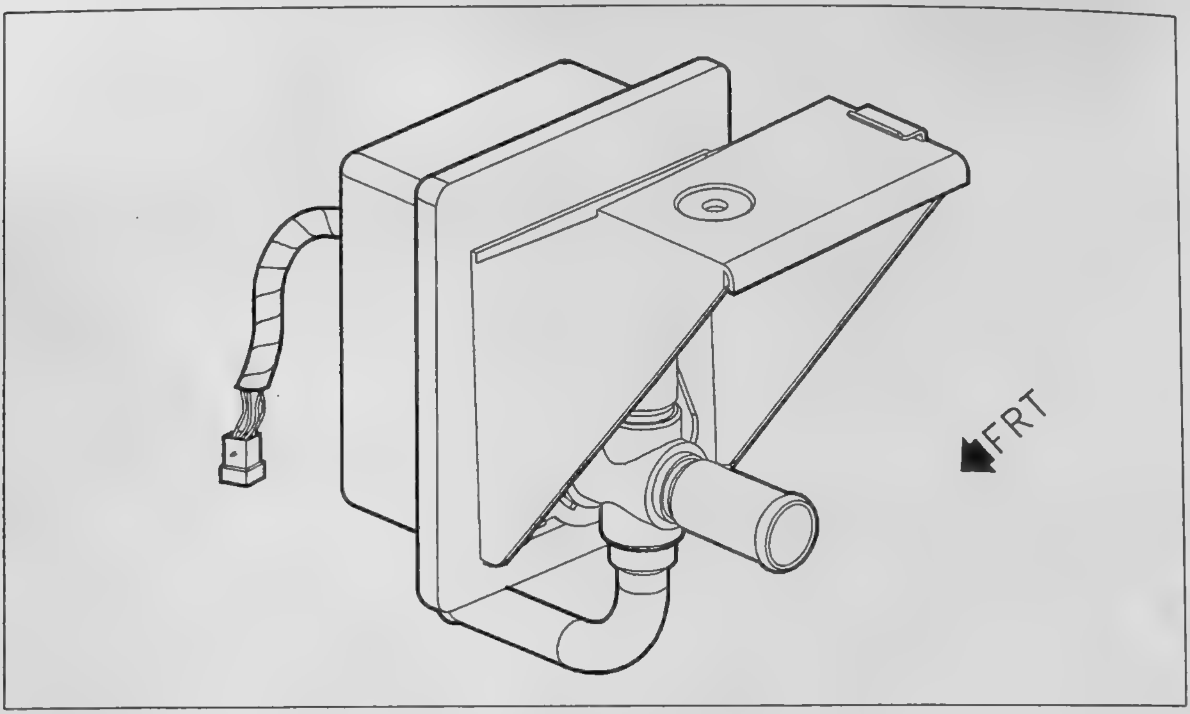
6. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



PSMPEN66661AA

GENERAL DESCRIPTION

DRIVE MOTOR BATTERY CHARGER RECEPTACLE COOLANT VALVE



PSMPEN66655AA

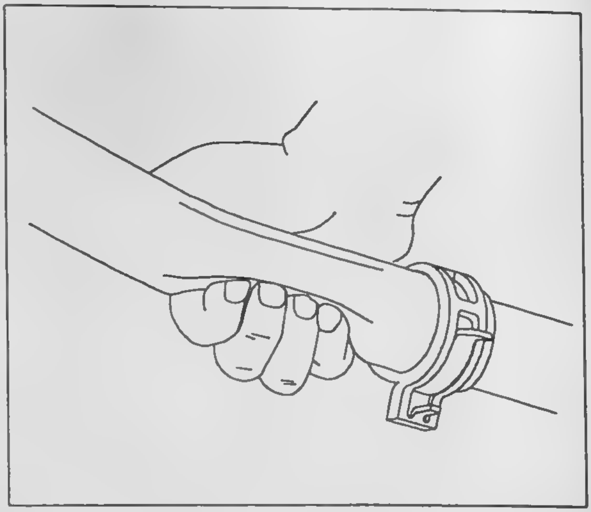
The drive motor battery charger receptacle coolant valve has two major components the mechanical diverter valve and the 12 volt actuator. The charger receptacle valve opens to allow coolant to flow into the charger receptacle during the charge mode of operation. During the run mode coolant flow is shut off at the valve. The 12 volt actuator is controlled by the HTCM and uses a 5 volt reference line to monitor position of the actuator and valve. The valve and actuator will default to the PEB/radiator mode if the HTCM detects a fault in the system.

HOSE AND CLAMP INSPECTION

The proper operation of the cooling system depends on the hoses and clamps being in good condition. Yet, these items are often taken for granted and overlooked. When these oversights occur, roadside emergencies will follow, which will lead to low customer satisfaction. These problems can be avoided by proper physical and visual inspection of hoses and clamps.

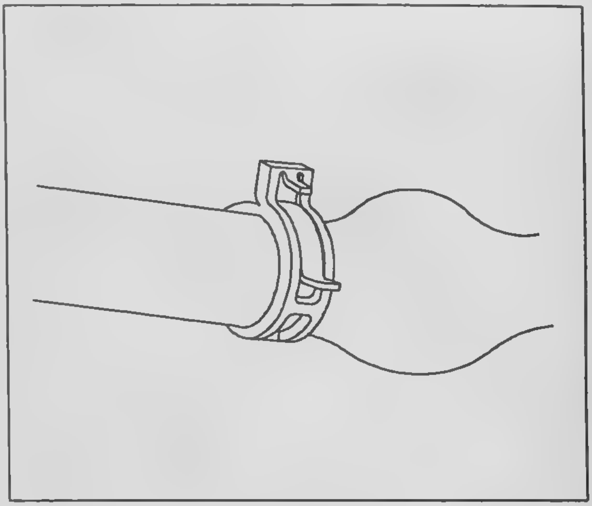
Hoses should not only be checked by means of a thorough visual inspection, but also by squeezing each hose along its entire length. Look for these problems:

1. Sponginess: If the hose collapses too easily as you feel along its length, it indicates deterioration and that means hose should be replaced.



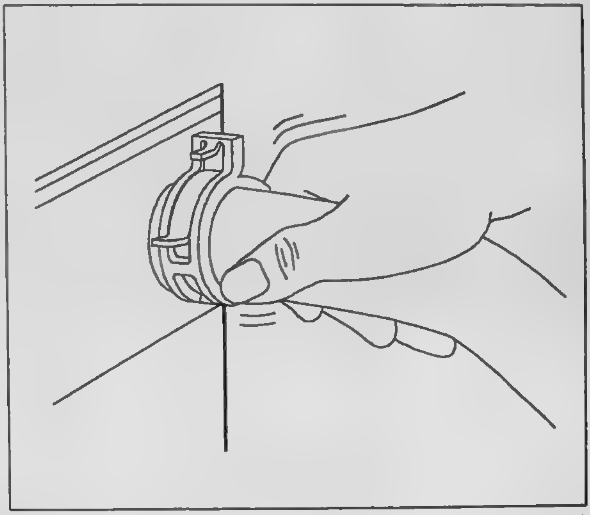
SMHVC50423AA

2. Bulging or Swelling: If you see this on the hose, it means there has been weakening under pressure, and replacement is again indicated.

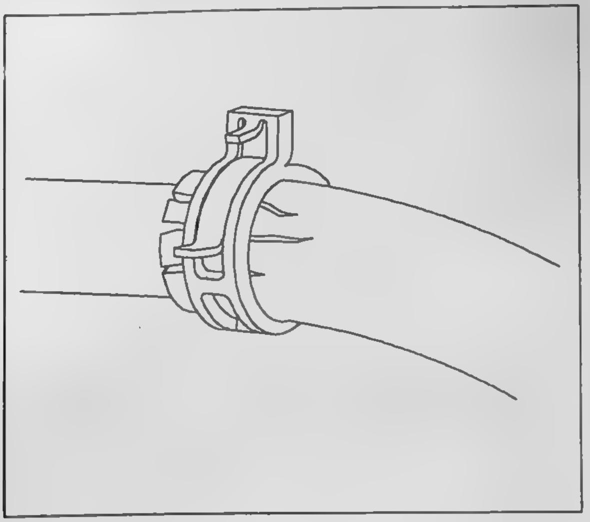


SMHVC50424AA

3. Brittleness: If as you feel and wriggle the hose it has a feeling of brittleness, an immediate replacement is required.

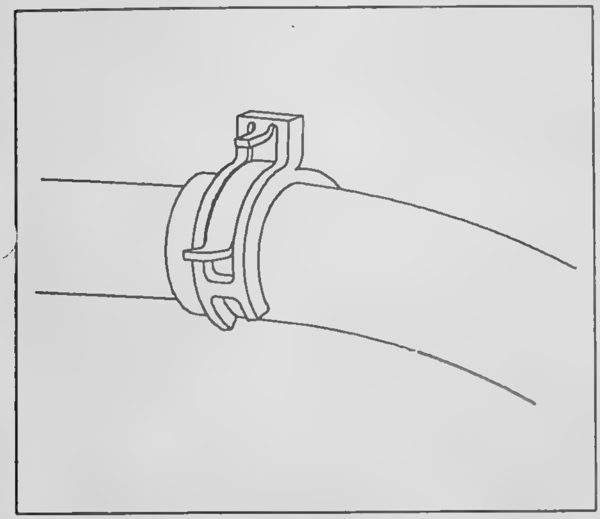


SMHVC50425AA



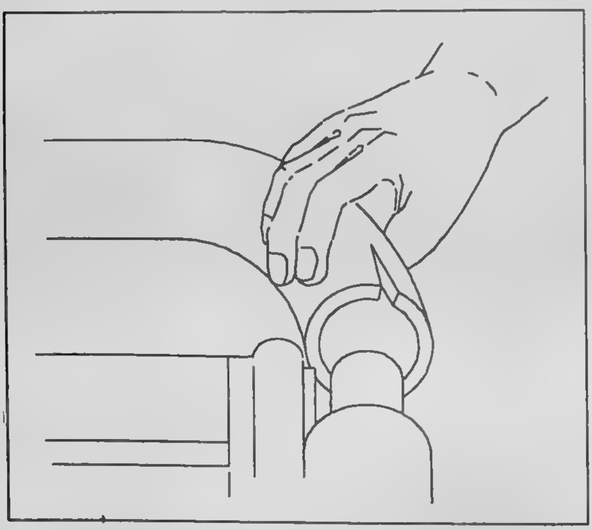
SMHVC50426AA

4. Cracking at the Point of Attachment: If seen during your visual inspection, immediate replacement is needed.



SMHVC50427AA

5. Broken Clamps: If seen, replace the clamp. Inspect the hose while it is off, and replace if any of the problems listed are apparent in the hose itself.



SMHVC50428AA

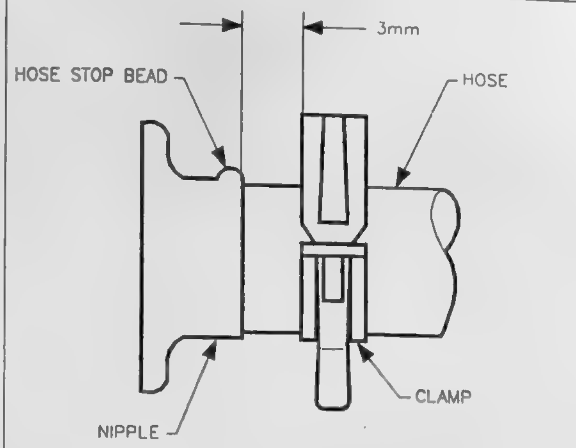
HOSE REPLACEMENT

If you find any one of the above problems existing in the hoses, they should be replaced.

1. Place the car into "Lock" mode.
2. When coolant system has cooled, follow the hose replacement procedure found in this seciton for the hose that requires replacement.
3. Slit hose end, twist left and right and pull straight off for easy removal.

4. Clean off outlets with clean cloth. Use sandpaper if necessary.
5. Dip ends of new hose into coolant for easier installation.
6. Install clamps on hose.
7. Install hose. Push-On. Be sure hose covers full length of outlets.
8. Slide clamp to within 3 mm (1/8 in.) of the hose end.

CAUTION: TO PREVENT PERSONAL INJURY, KEEP HANDS AWAY FROM ALL MOVING PARTS WHILE VEHICLE IS IN *RUN* MODE

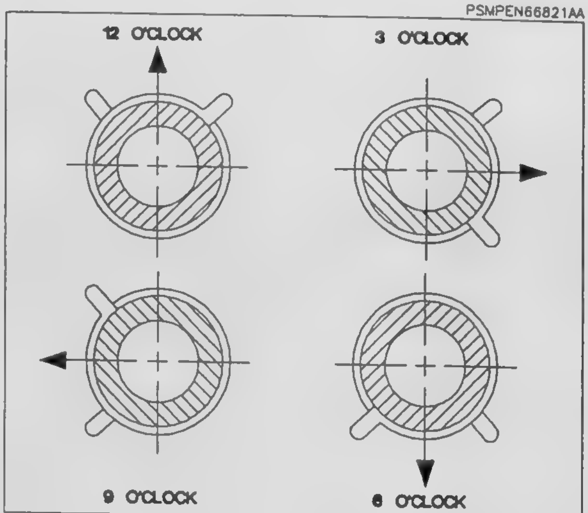


TYPICAL HOSE CLAMPING

PSMPEN66821AA

CLAMP POSITIONING

IMPORTANT: Hose clamps have been positioned at the factory for ease of assembly and removal in service. Clock positions are called out for all installations (refer to illustration). Clamps must be installed in designed position to prevent damage to other components. Spring clamps shown in illustration.



PSMPEN66843AA

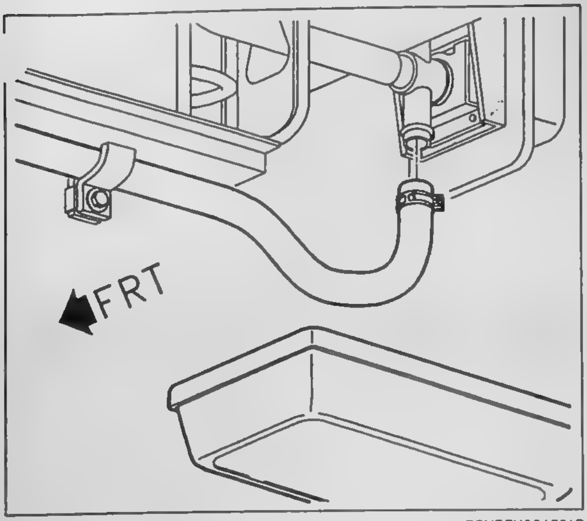
HEATER INLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.

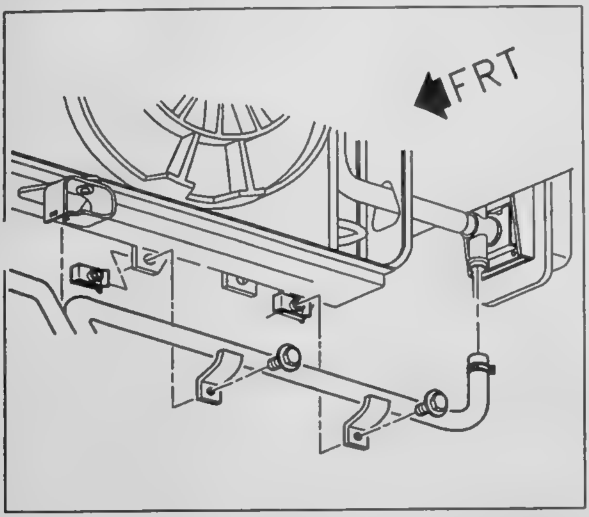
IMPORTANT: Coolant will flow from both the hose and the valve fitting.

3. Position drain pan under the right hand mid-rail under the coolant recovery check valve. Remove lower clamp and hose on recovery check valve draining coolant from the heater core and the valve.



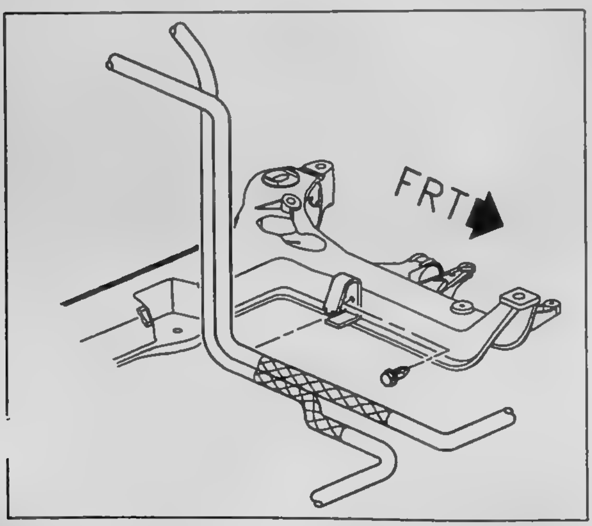
PSMPEN66460AB

4. Disconnect hose retainers at lower radiator support.



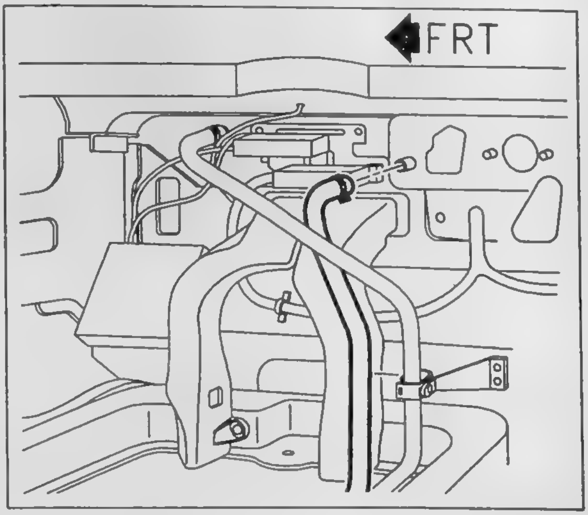
PSMPEN66456AB

5. Disconnect hose retainers at left side of cradle.



PSMPEN66299AB

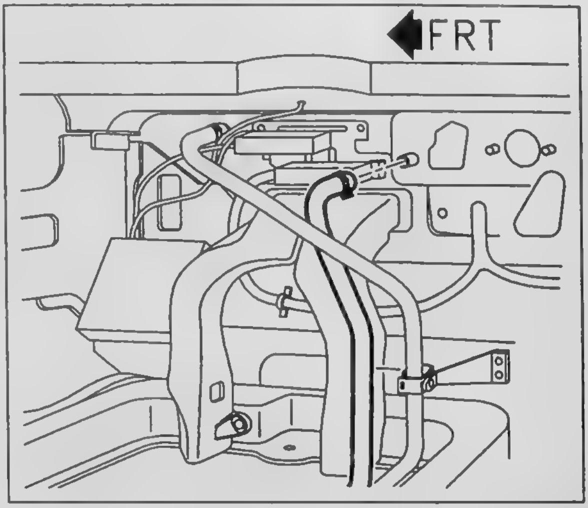
6. Lower vehicle.
7. Disconnect hose retainer at front of dash.
8. Remove clamp and hose from heater core inlet.
9. Raise vehicle.
10. Remove heater inlet hose from underneath the vehicle.



PSMPEN66560AB

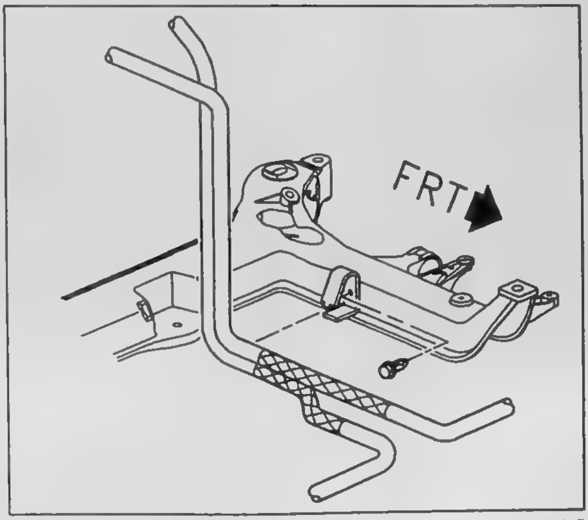
INSTALLATION

1. Route heater inlet hose from underneath vehicle.
2. Connect hose retainer at front of dash.

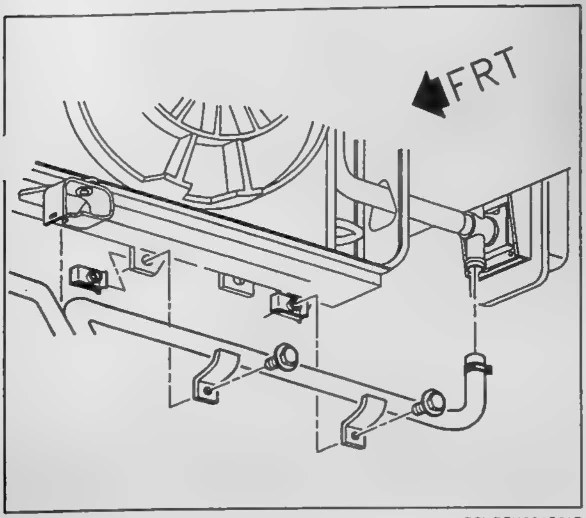


PSMPEN66560AB

3. Connect hose retainers at left side of cradle.

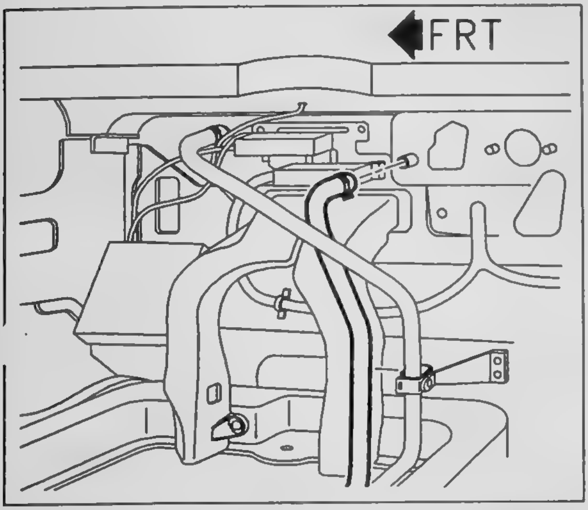


PSMPEN66299AB



PSMPEN66456AB

4. Connect hose retainers at lower radiator support.
5. Install hose and clamp on recovery check valve lower fitting. Position clamp tangs at 4 o'clock.
6. Lower vehicle.



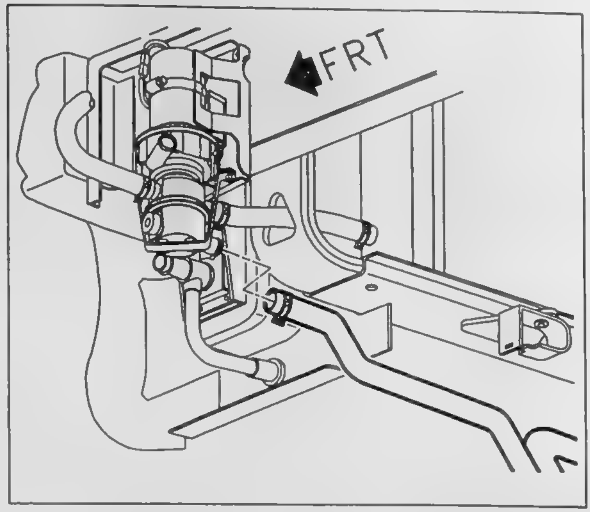
PSMPEN66560AB

7. Install hose and clamp on heater core inlet. Position clamp tangs at 12 o'clock.
8. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
9. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

HEATER OUTLET HOSE

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Remove clamp and hose from water pump manifold.
4. Disconnect hose retainer at lower radiator support.



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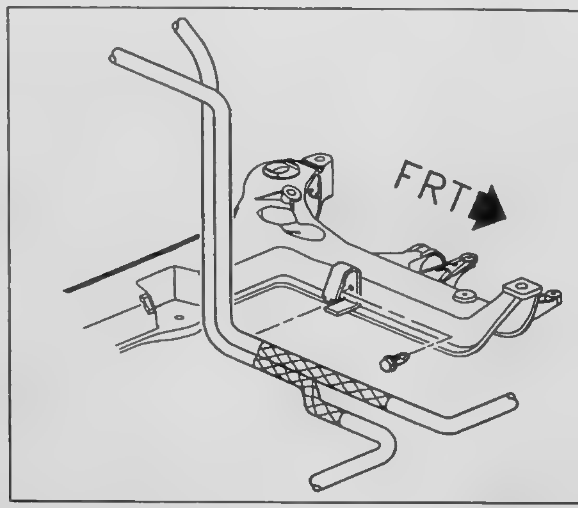
5. Disconnect hose retainers at left side of cradle.



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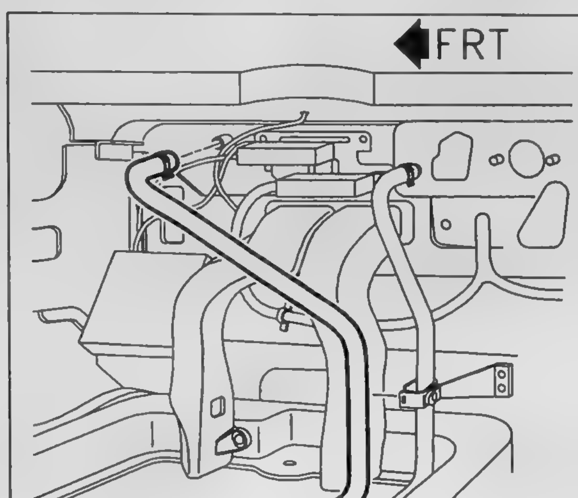
6. Lower vehicle.
7. Disconnect hose retainer at front of dash.
8. Remove clamp and hose from heater core outlet.
9. Raise vehicle.
10. Remove heater outlet hose from underneath the vehicle.



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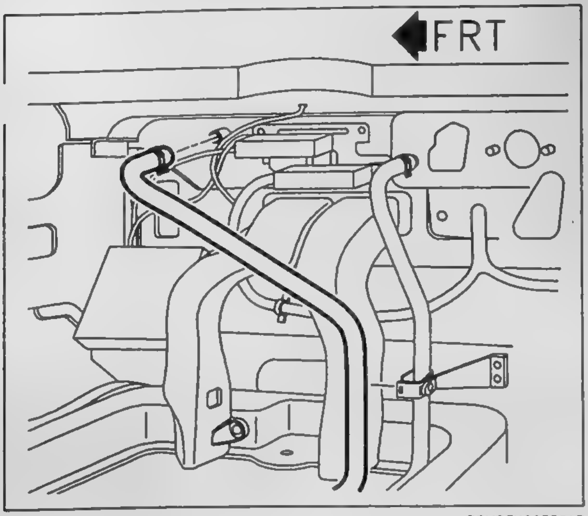

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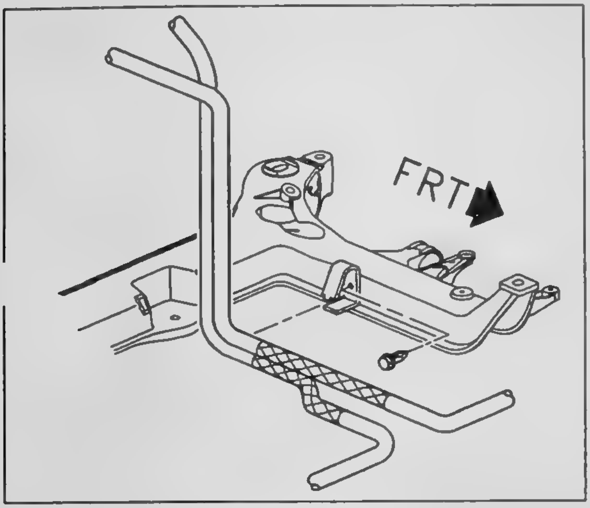
INSTALLATION

1. Route heater outlet hose from underneath vehicle.
2. Connect hose retainer at front of dash.



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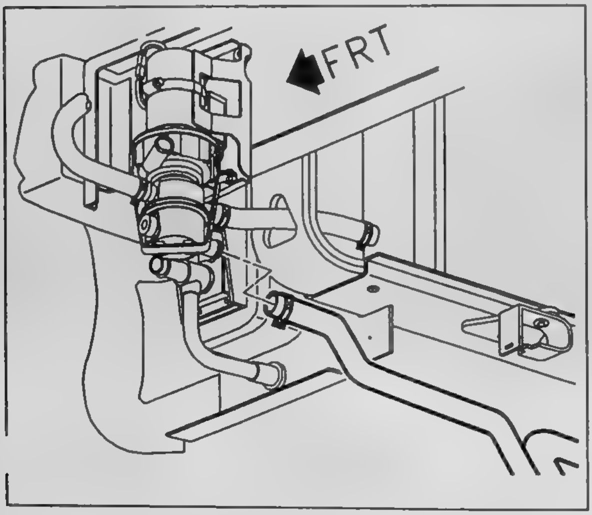
3. Connect hose retainers at left side of cradle.



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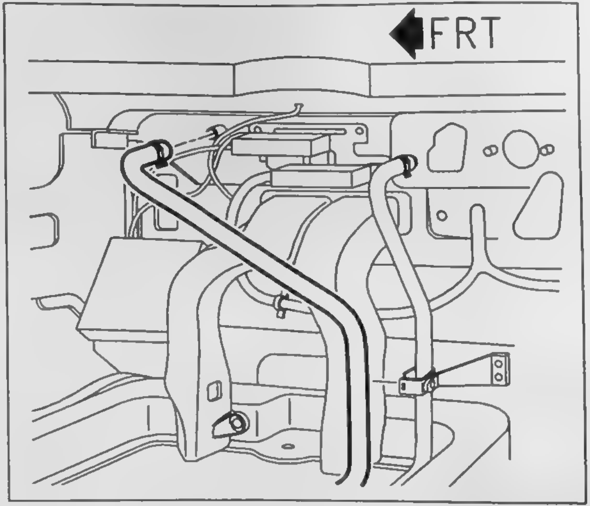
4. Connect hose retainers at lower radiator support.
5. Install hose and clamp on water pump manifold fitting. Position clamp tangs at 6 o'clock.
6. Lower vehicle.

7. Install hose and clamp on heater core outlet. Position clamp tangs at 3 o'clock.

8. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.

9. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



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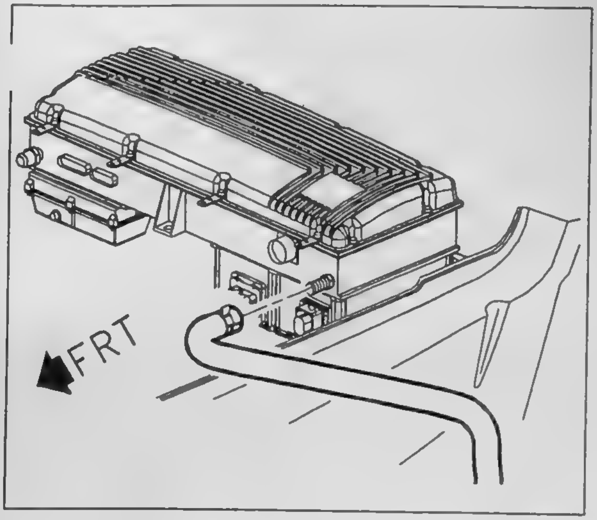

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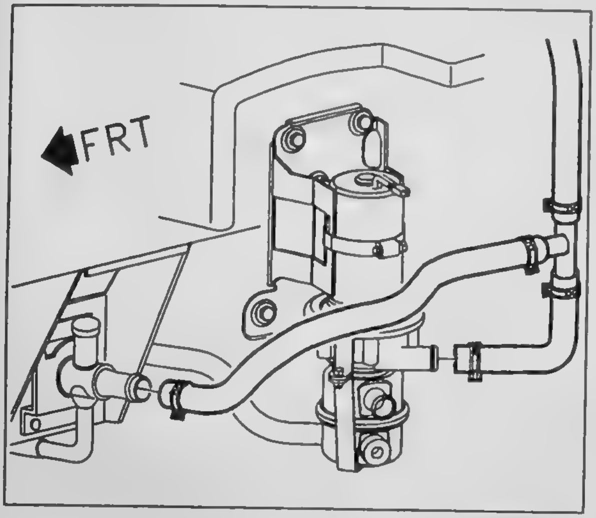
11. Remove clamp and hose from PEB.
12. Remove hose from vehicle through the wheel house opening.

INSTALLATION

1. Route hose through the wheel well opening. Verify the protective sleeve is positioned over the mid-rail and compressor on the tee fitting to PEB hose. Route charger receptacle to tee fitting on the outboard side of the pump and inboard of the coolant recovery expansion tank outlet hose.
2. Install hose and clamp on PEB. Position clamp tangs at 2 o'clock.
3. Raise vehicle.



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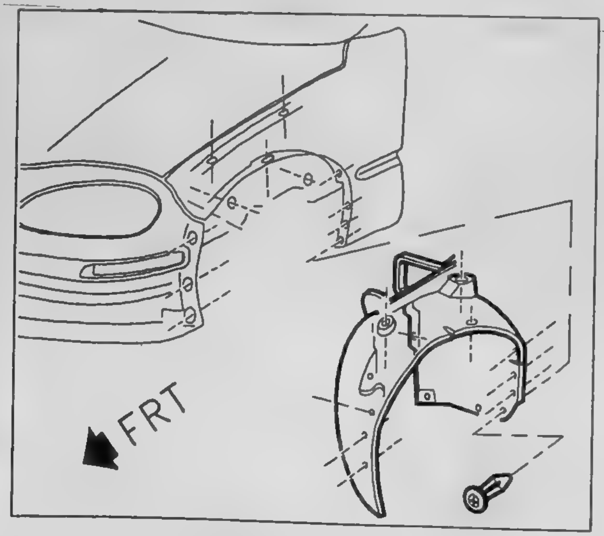
4. Install hose and clamp on charge receptacle valve. Position clamp tangs at 6 o'clock.
5. Install hose and clamp on water pump. Position clamp tangs at 6 o'clock.
6. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.



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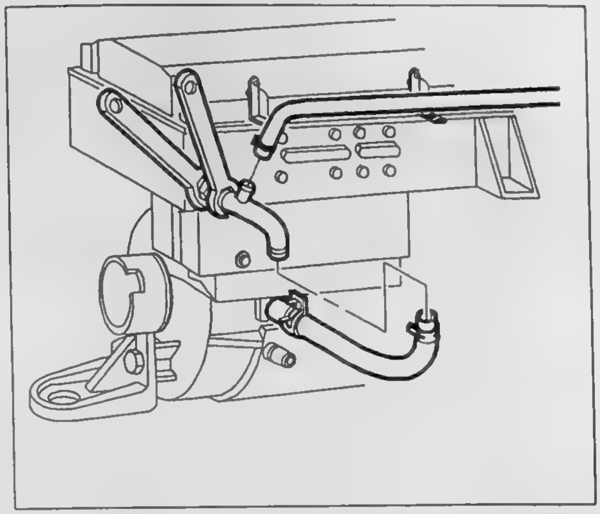
7. Position wheelhouse panel liner into opening.
8. Tuck center section of outer edge of wheelhouse panel liner behind fender attachment location.
9. Install plastic retainers at outer edge of panel.
10. Install plastic fasteners to inner wheelhouse panel liner.
11. Install bolts/screws at wheelhouse panel liner to front underbody air deflector assembly.
12. Install front wheel and tire assembly. Torque lug nuts as specified.

Torque: **120 N•m (89 ft–lbs)**

13. Lower vehicle.
14. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

DRIVE MOTOR CONTROL MODULE COOLING HOSE CONNECTOR



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REMOVAL

1. Drain coolant as outlined in "main path coolant draining" procedure found in this service manual.
2. Remove drive motor cooling clamp and hose from cooling hose connector.
3. Remove expansion tank inlet clamp and hose from cooling hose connector.

NOTICE: **Always use a wrench to back up the opposing fitting when disconnecting connections. Failure to use a wrench to back up fittings could cause distortion of connections, fittings or components.**

4. Using a wrench to back up the cooling hose connector fitting on the power electronics bay (PEB), loosen fitting on the cooling hose connector. Remove cooling hose connector from vehicle.

INSTALLATION

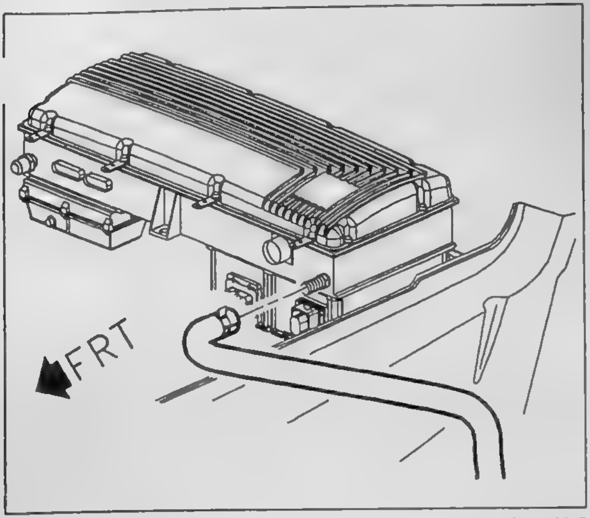
1. Hand start cooling hose connector fitting onto PEB fitting.

NOTICE: **Always use a wrench to back up the opposing fitting when disconnecting connections. Failure to use a wrench to back up fittings could cause distortion of connections, fittings or components.**

2. Using a wrench to back up the cooling hose connector fitting on the power electronics bay (PEB), tighten cooling hose connector fitting.

Torque: 100 N•m (74 ft–lbs)

3. Install drive motor cooling hose and clamp on cooling hose connector. Position clamp tangs at 9 o'clock.
4. Install expansion tank inlet hose and clamp on cooling hose connector. Position clamp tangs at 6 o'clock.
5. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.



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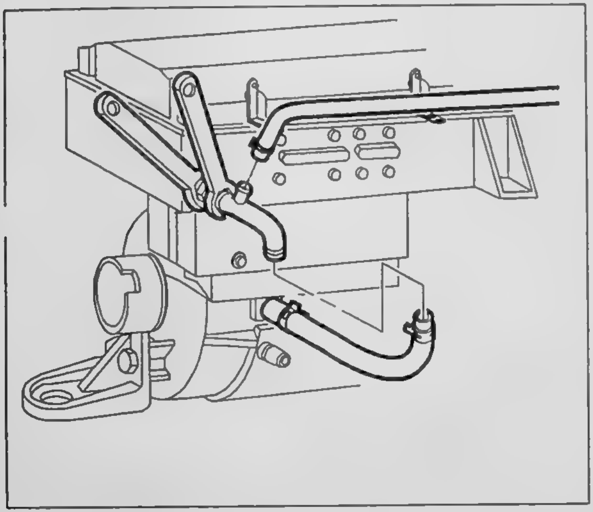
PEB COOLING FITTINGS

REMOVAL

1. Drain coolant. (Refer to "Coolant Drain" procedure in this manual.)
2. Remove water pump outlet from driver side PIM cooling fitting.
3. Remove the cooling tube from the passenger side PIM cooling fitting.
4. Remove the fitting by unscrewing it from the PIM chassis.



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INSTALLATION

1. Clean the PEB cooling fitting and mating surface. Apply pipe sealant to the cooling fitting.
2. Install cooling fittings tighten and torque.

Torque: **27 N•m (20 ft−lb)**

3. Install water pump outlet hose. Position clamp tangs at 2 o'clock.
4. Install passenger side cooling tube and tighten tube nut and torque.

Torque: **36 N•m (27 ft−lbs)**

NOTICE: **Always use a wrench to back up the opposing fitting when disconnecting connections. Failure to use a wrench back up fittings could cause distortion of connections, fittings or components.**

5. Fill coolant. (Refer to "Coolant Fill" procedure in this manual.)

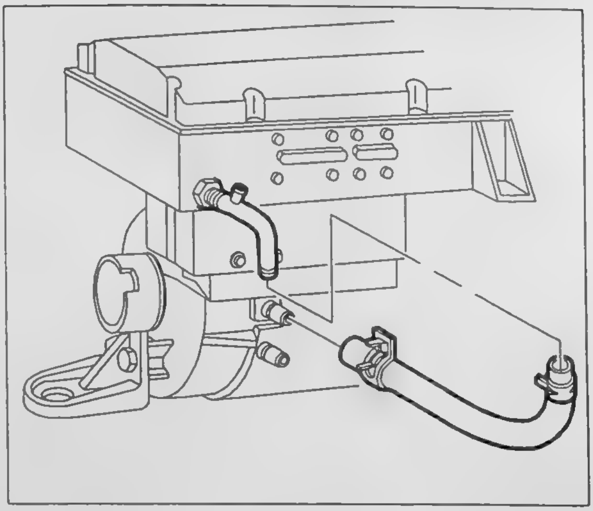
DRIVE MOTOR CONTROL MODULE COOLING OUTLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Lower vehicle.
4. Remove clamp and hose from connector.
5. Remove clamp, slit hose end remove hose from drive unit.

INSTALLATION

1. Lube new hose ends with coolant. Install new hose and clamp on drive unit. Position clamp tangs at 9 o'clock.
2. Install hose and clamp on connector. Position clamp tangs at 9 o'clock.
3. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
4. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



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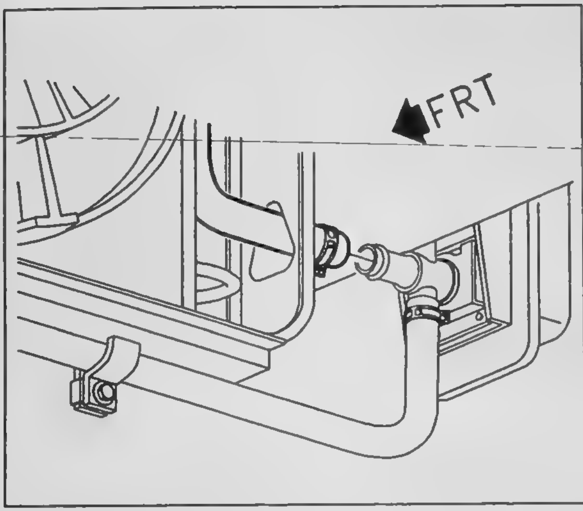
COOLANT RECOVERY CHECK VALVE INLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Remove coolant valve from midrail.
4. Remove clamp and hose from coolant valve center fitting.

IMPORTANT: Coolant will flow from both the hose and the valve fitting.

5. Lower vehicle.



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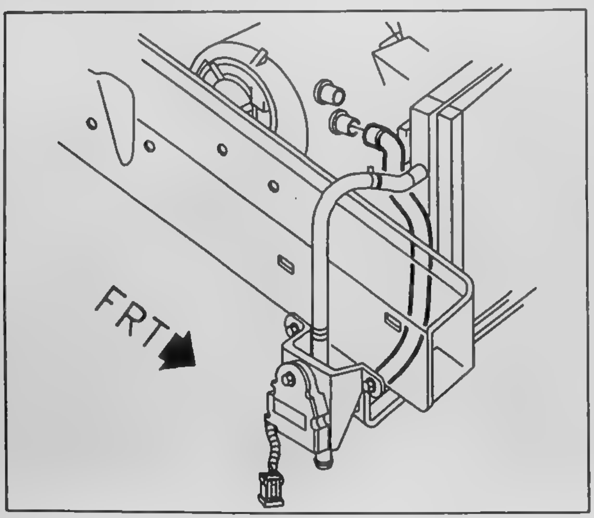
6. Remove clamp, slit hose end, remove hose from lower drive unit fitting.
7. Remove hose from vehicle.



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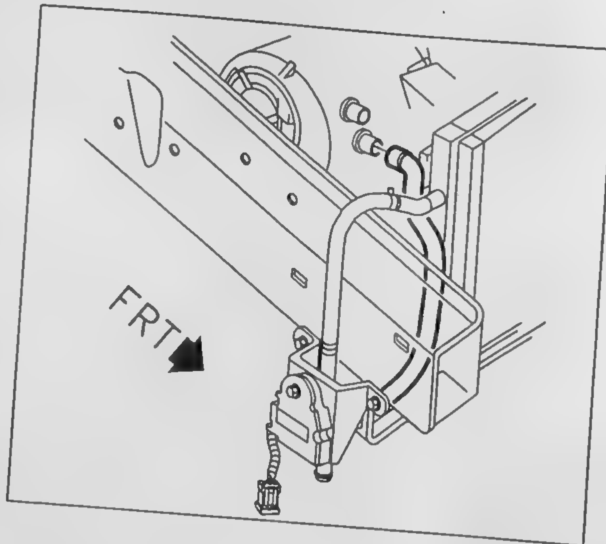
INSTALLATION

1. Route new hose through the lower radiator support pass through opening to the coolant valve. Verify that the protective sleeve is positioned at the pass through opening.
2. Install hose and clamp on lower drive unit fitting. Position clamp tangs at 9 o'clock.
3. Raise vehicle.



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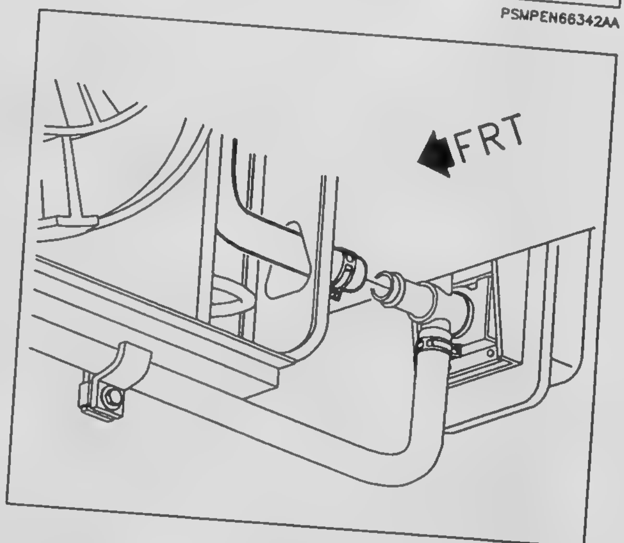
4. Install hose and clamp on coolant valve. Position clamp tangs at 3 o'clock. Install coolant valve.

Torque: **10 N•m (89 in–lbs)**

5. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
6. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



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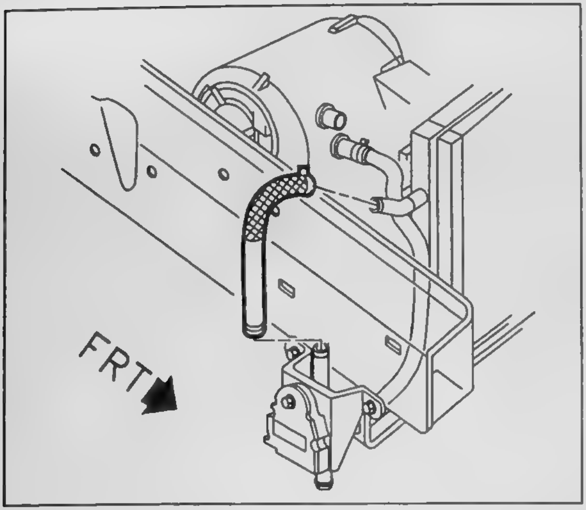

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RADIATOR INLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to “Lifting and Jacking Support Points” in this manual.)
2. Drain coolant as outlined in “Main Path Coolant Draining” procedure found in this service manual.
3. Remove coolant recovery check valve from mid-rail.
4. Remove clamp and hose from coolant valve upper fitting.

IMPORTANT: Coolant will flow from both the hose and the valve fitting.

5. Lower vehicle.
6. Remove clamp and hose from radiator.
7. Remove hose from vehicle.

INSTALLATION

1. Route hose over the right mid-rail to coolant valve. Verify that the protective sleeve is positioned over mid-rail.
2. Install hose and clamp on radiator. Position clamp tangs at 12 o’clock.
3. Raise vehicle.
4. Install hose and clamp on coolant valve. Position clamp tangs at 9 o’clock.
5. Install coolant valve onto mid-rail.

Torque: **10 N•m (89 in–lbs)**

6. Fill coolant as outlined in “Fill Coolant System” procedure found in this service manual. Check for leaks.
7. Install underbody front air deflector assembly. (Refer to “Underbody Front Air Deflector Assembly” in this manual.)

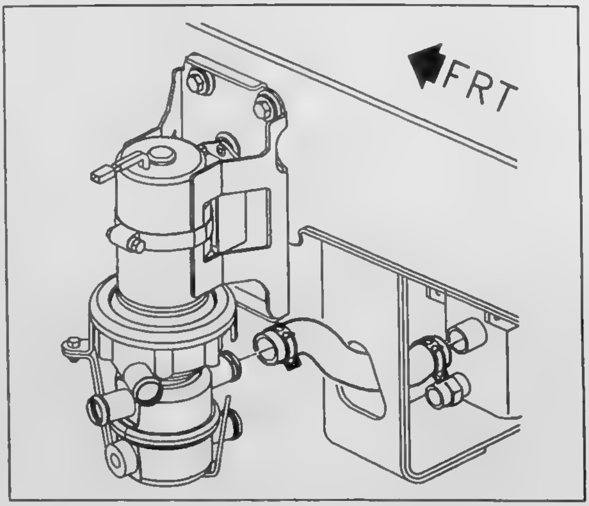
RADIATOR OUTLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Remove clamp and hose from radiator. Access to the hose and clamp is from under the vehicle and rearward of radiator.
4. Remove clamp and hose from water pump manifold.

INSTALLATION

1. Route hose through lower radiator support pass though opening. Verify that the protective sleeve is located at the pass through opening.
2. Install hose and clamp on radiator. Position clamp tangs at 4 o'clock.
3. Install hose and clamp on water pump manifold. Position clamp tangs at 8 o'clock.
4. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
5. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



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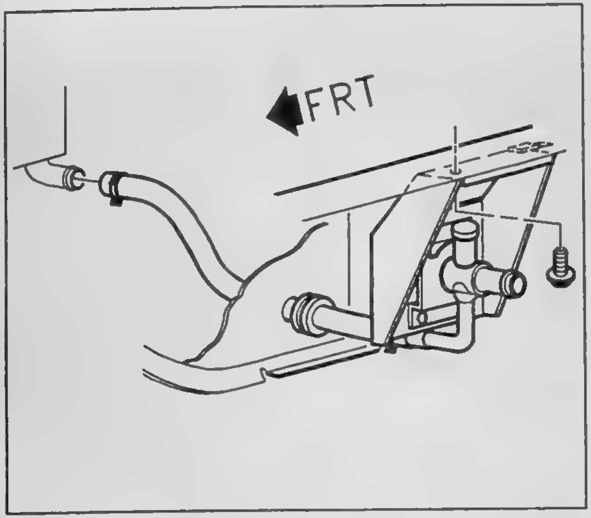

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DRIVE MOTOR BATTERY CHARGER RECEPTACLE COOLING INLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Remove clamp and hose from charger receptacle.

IMPORTANT: Coolant will flow from both the hose and the valve fitting.

4. Remove clamp and hose from the charger receptacle valve.
5. Remove grommet in the radiator side air baffle. Remove hose from vehicle.

INSTALLATION

1. Install charger receptacle valve hose end through the grommet hole in the radiator side air baffle. Install grommet into side air baffle.
2. Install hose and clamp on charger receptacle valve. Position clamp tangs at 6 o'clock.
3. Install hose and clamp on charger receptacle. Position clamp tangs at 6 o'clock.
4. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
5. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

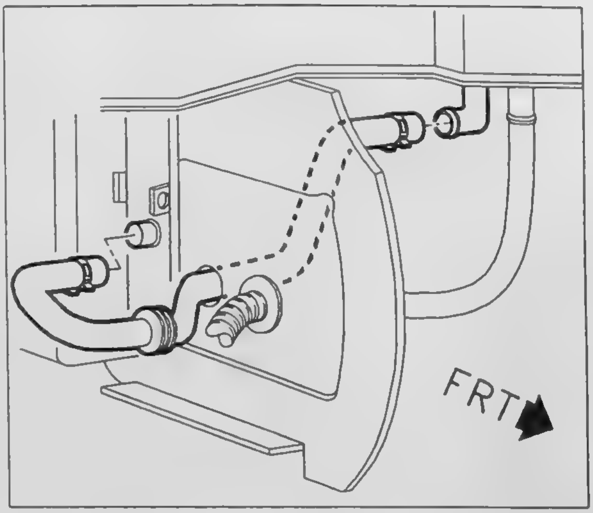
DRIVE MOTOR BATTERY CHARGER RECEPTACLE COOLING OUTLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Remove clamp and hose from charger receptacle.

IMPORTANT: Coolant will flow from both the hose and the charger receptacle fitting.

4. Remove clamp and hose from radiator.
5. Remove grommet in the radiator side air baffle. Remove hose from vehicle.



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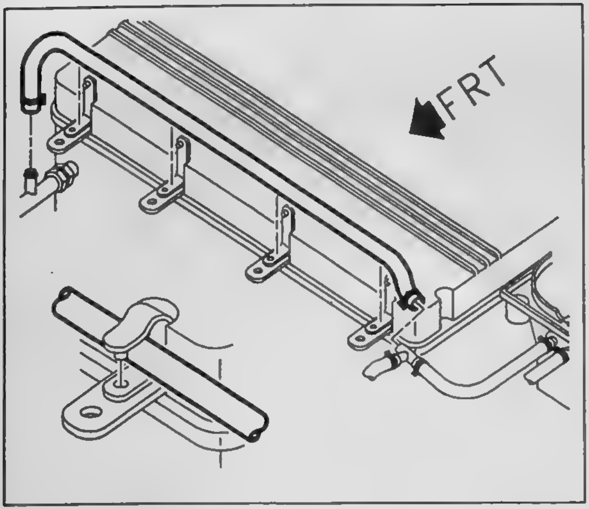
INSTALLATION

1. Install charger receptacle hose end through the grommet hole in the radiator side air baffle. Install grommet into side air baffle.
2. Install hose and clamp on charger receptacle. Position clamp tangs at 6 o'clock.
3. Install hose and clamp on radiator. Position clamp tangs at 8 o'clock.
4. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
5. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)



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COOLANT RECOVERY EXPANSION TANK INLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Lower vehicle.
4. Disconnect inlet hose retainers. Remove clamp and hose from connector.
5. Remove clamp and hose from tee fitting near the expansion tank.

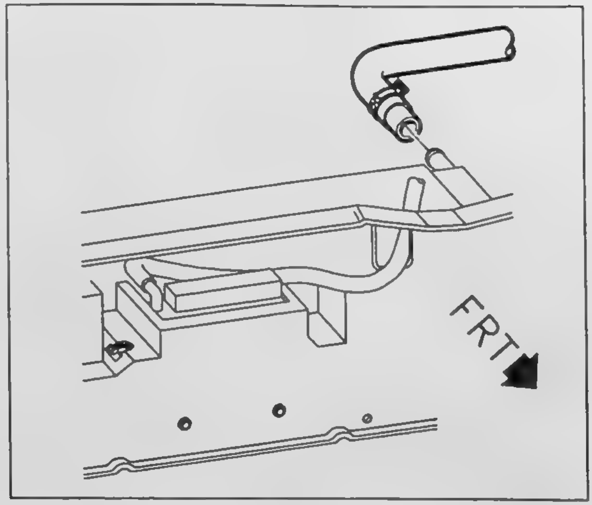
INSTALLATION

1. Route hose along power inverter module and connect vent hose retainers.
2. Install hose and clamp on connector. Position clamp tangs at 6 o'clock.
3. Install hose and clamp on tee fitting. Position clamp tangs at 12 o'clock.
4. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
5. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

RADIATOR VENT OUTLET HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Lower vehicle.
4. Remove clamp and hose from radiator.



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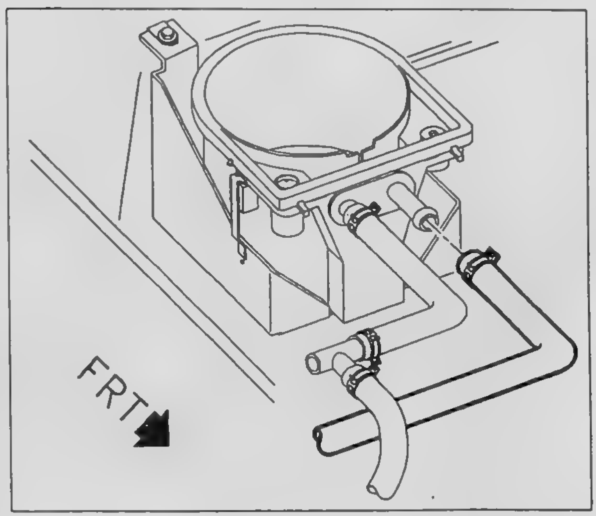
5. Remove clamp and hose from expansion tank.



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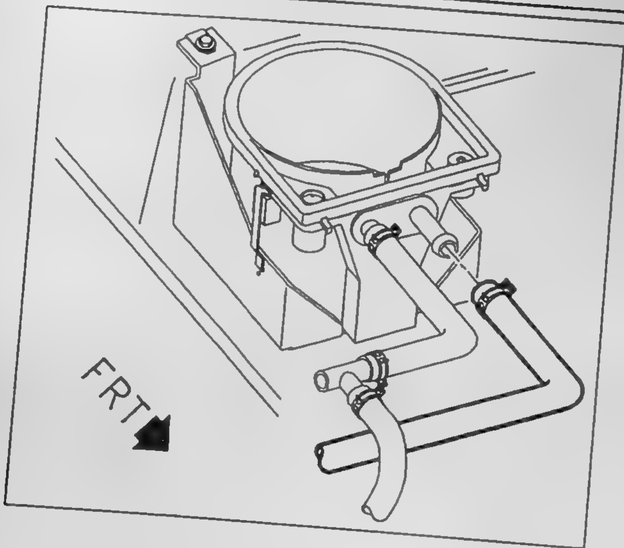

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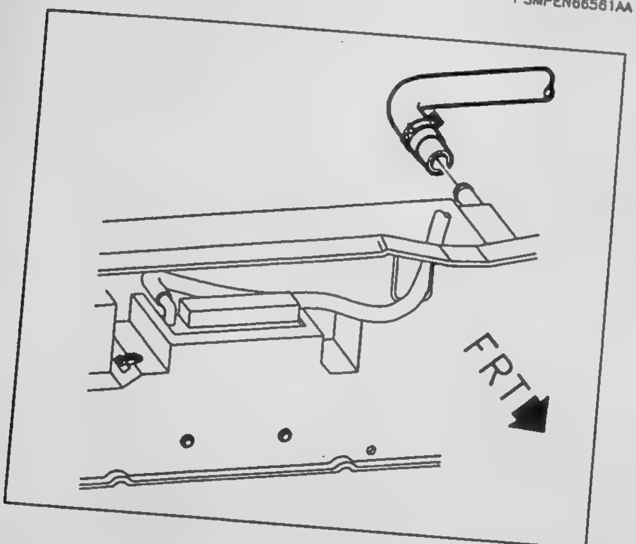
INSTALLATION

1. Install hose and clamp on expansion tank. Position clamp tangs at 3 o'clock.



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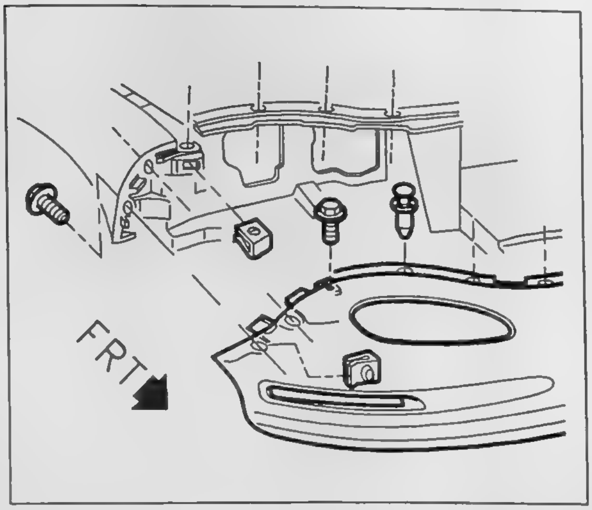
2. Install hose and clamp on radiator. Position clamp tangs at 12 o'clock.
3. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
4. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

DRIVE MOTOR BATTERY CHARGER RECEPTICLE COOLANT OUTLET REAR HOSE ASSEMBLY

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Remove retainers from top of front bumper fascia assembly.
4. Remove bolts retaining front underbody air deflector to front bumper fascia assembly.
5. Remove retainers from front of wheelhouse liner on each side of vehicle.
6. Remove bolts attaching front fender to fascia bumper fascia assembly on each side of vehicle.
7. Remove front bumper fascia assembly from front end panel.
8. Disconnect electrical connectors from front parking, turn signal, and side marker light assemblies.
9. Remove clamp and hose from charger receptacle.



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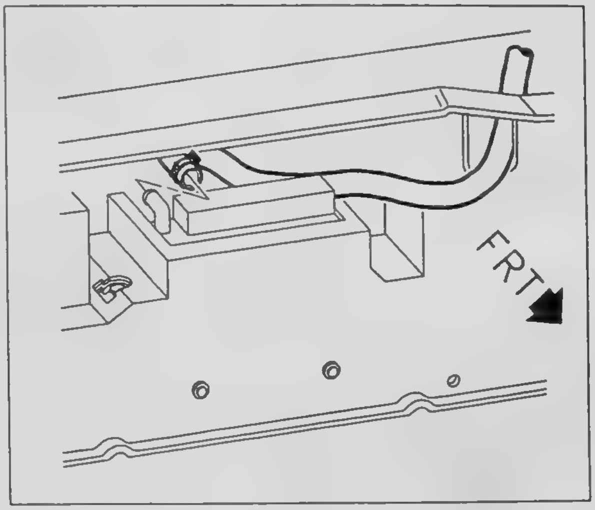

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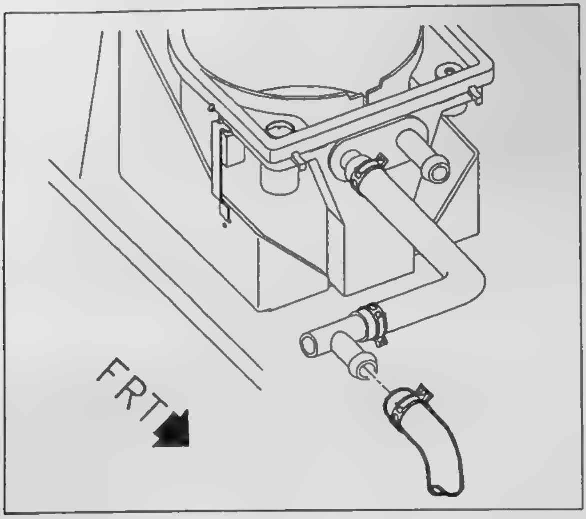

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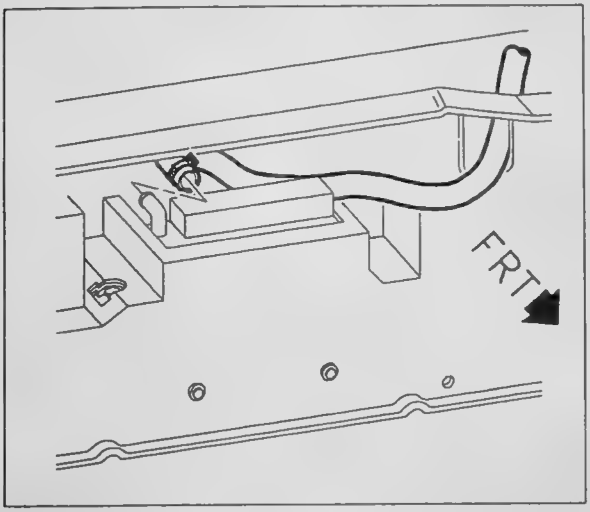
10. Remove clamp and hose from "T" fitting.



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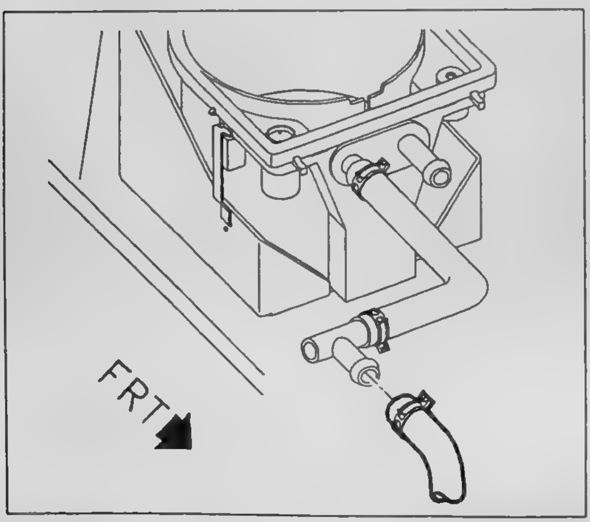
INSTALLATION

1. Route hose through front end panel. Verify protective sleeve is position at the front end panel pass through opening. Tuck hose under lip on the front end panel.
2. Connect hose and clamp on charger receptacle. Position clamp tangs at 12 o'clock.



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3. Connect hose and clamp on "T" fitting. Position clamp tangs at 12 o'clock.
4. Connect electrical connectors to front parking, turn signal, and side marker light assemblies.
5. Install and align front fascia assembly to front end panel. Check alignment to hood and front fender assemblies.

IMPORTANT: Refer to "Clearance and Flushness Specifications" in the "General Information" section of this manual for panel alignment specifications.

6. Install retainers to top surface of front bumper fascia assembly.

7. Install front bumper fascia assembly to fenders with bolts on each side of vehicle. Torque as specified.

Torque: 6 N•m (53 in–lbs)

8. Install wheelhouse to front bumper fascia assembly retainers.

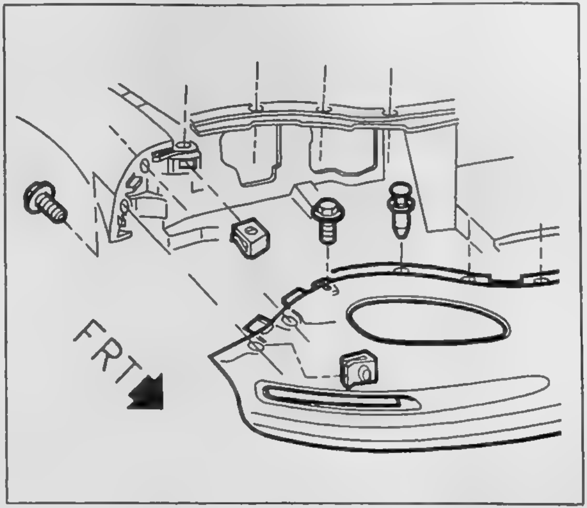
9. Install bolts retaining front underbody air deflector assembly to front bumper fascia assembly. Torque as specified.

Torque: 6 N•m (53 in–lbs)

10. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.

11. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

12. Lower vehicle.



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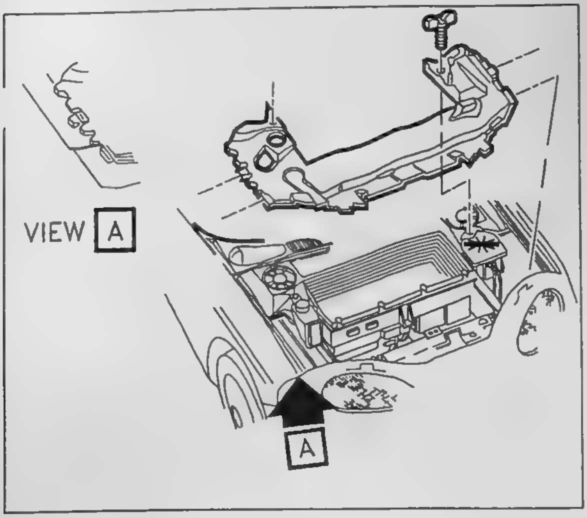

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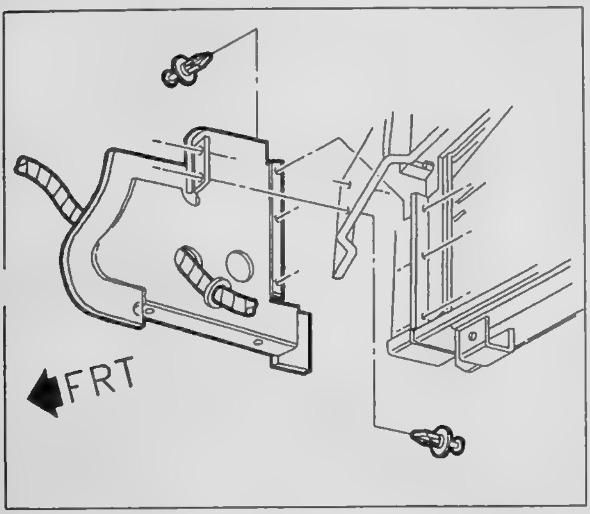
RADIATOR SIDE MOUNTING PANEL RIGHT OR LEFT SIDE

REMOVAL

1. Remove engine compartment sight shield.



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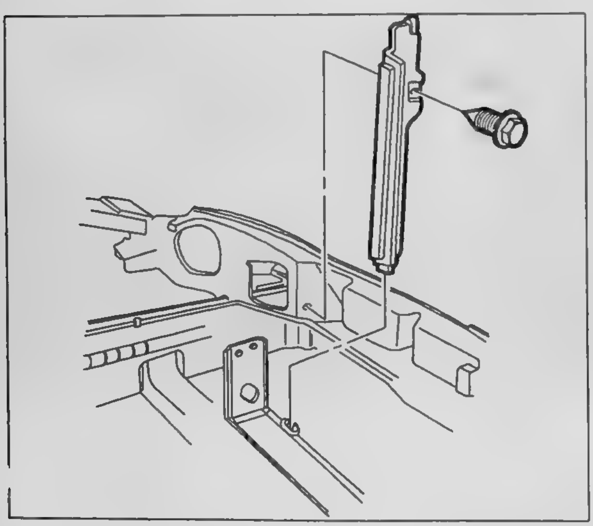
2. Remove radiator as outlined in "Radiator Removal" procedure found in this service manual.
3. If right radiator side mounting panel is removed, then remove scrivits from right vertical air path panel.



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4. Lower vehicle.
5. Remove bolt from side mounting panel.
6. Remove the radiator side mounting panel between radiator assembly and the front end panel by lifting upward.

INSTALLATION

1. Install the radiator side mounting panel. Insert side mounting panel into slotted retainer in the lower radiator support.
2. Install radiator side mounting panel bolt.
3. Install radiator as outlined in "Radiator Installation" procedure found in this service manual.
4. Install right vertical air path panel if the right side radiator side mounting panel was installed.

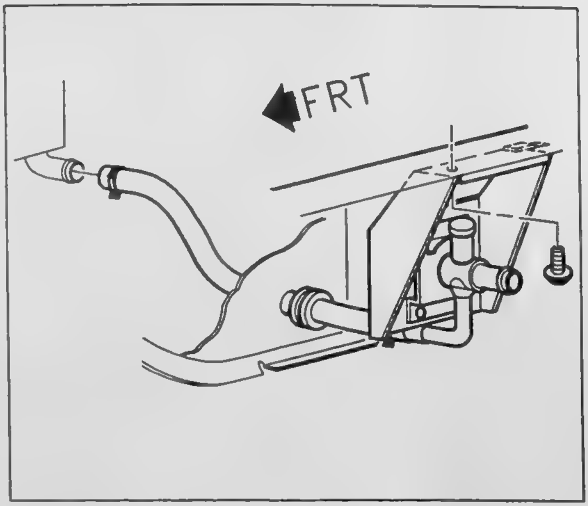
SIDE RADIATOR AIR PATH PANEL BAFFLE LEFT SIDE

REMOVAL

1. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)
2. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
3. Remove clamp and hose from charger receptacle.

IMPORTANT: Coolant will flow from both the hose and the valve fitting.

4. Remove clamp from hose at the charger receptacle valve end. Remove grommet in the radiator side air baffle. Remove hose with grommet from side air baffle.



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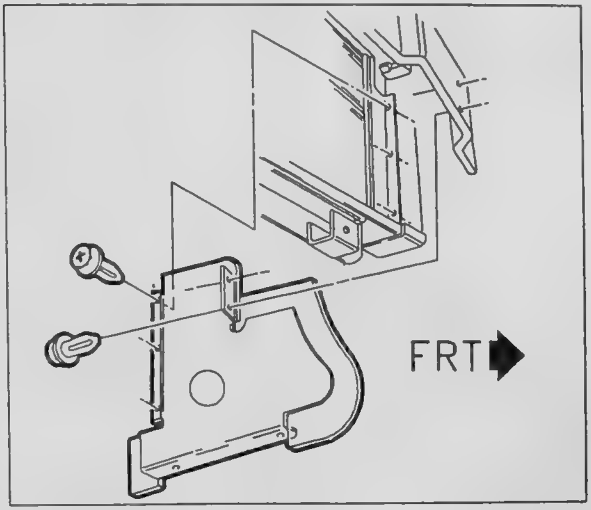
5. Remove retainers from left side air baffle. Remove baffle from vehicle.



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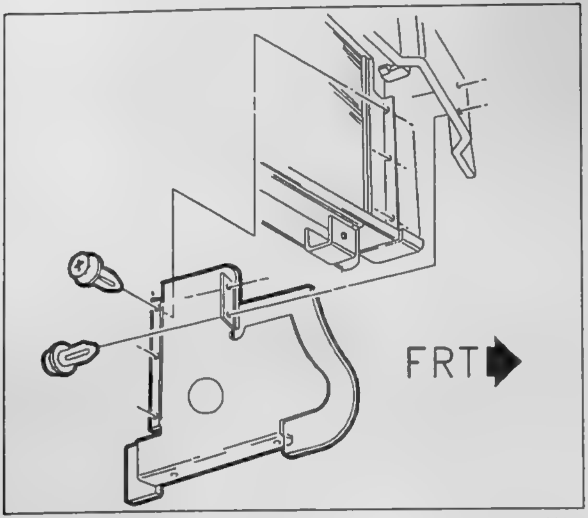

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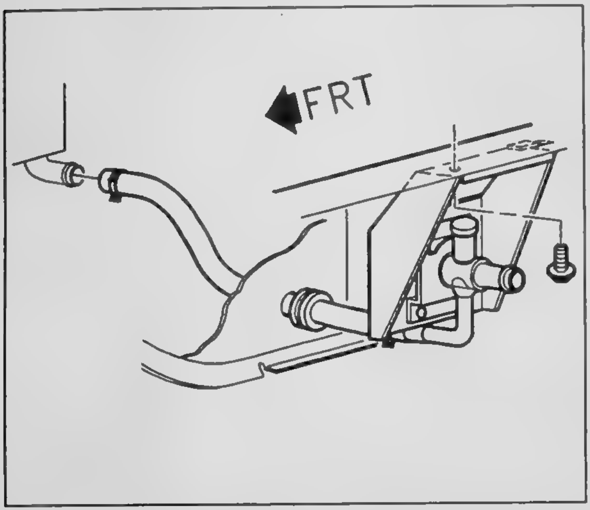
INSTALLATION

1. Install radiator side air baffle.



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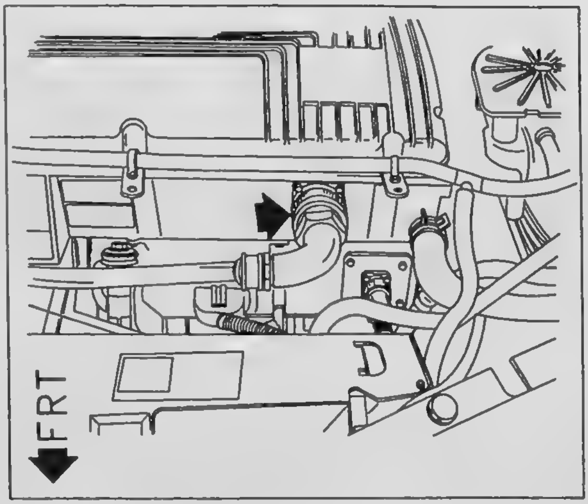
2. Route charger receptacle valve hose end grommet in the radiator side air baffle.
3. Install hose and clamp on charger receptacle valve. Position clamp tangs at 6 o'clock.
4. Install hose and clamp on charger receptacle. Position clamp tangs at 6 o'clock.
5. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
6. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

SIDE RADIATOR AIR PATH PANEL BAFFLE RIGHT SIDE

REMOVAL

CAUTION: TO REDUCE THE RISK OF SEVERE SHOCKS AND BURNS, THE HIGH VOLTAGE SYSTEM SHOULD BE DISABLED ANY TIME SERVICE WORK IS BEING PERFORMED ON OR AROUND THE HIGH VOLTAGE SYSTEM. WHEN IN DOUBT, ALWAYS DISABLE THE HIGH VOLTAGE SYSTEM. THE 12 VOLT SYSTEM WILL STILL BE ACTIVE AFTER THE HIGH VOLTAGE SYSTEM HAS BEEN DISABLED.

1. Disable high voltage. (Refer to "High Voltage Disable" procedure in this manual.)
2. Disconnect charger receptacle connection at PEB.



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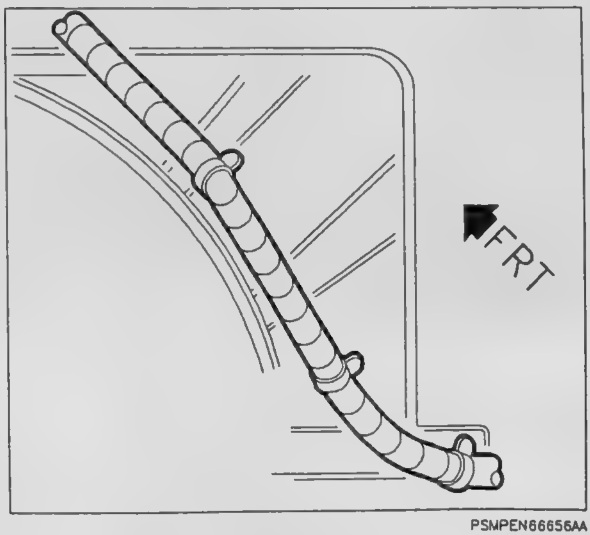
3. Disconnect charger receptacle cable. Rose bud retainers from fan shroud.



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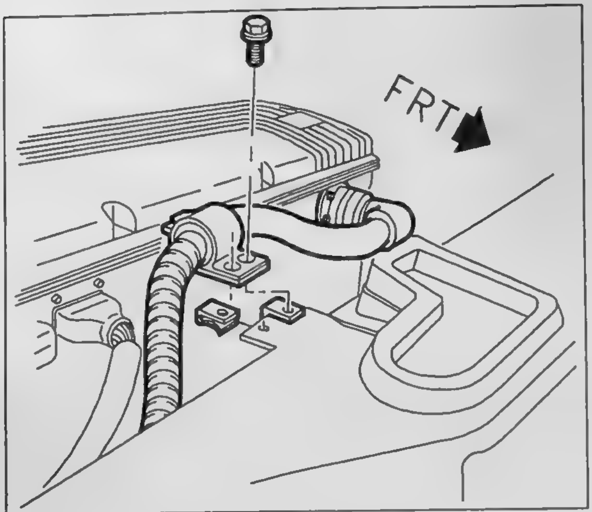

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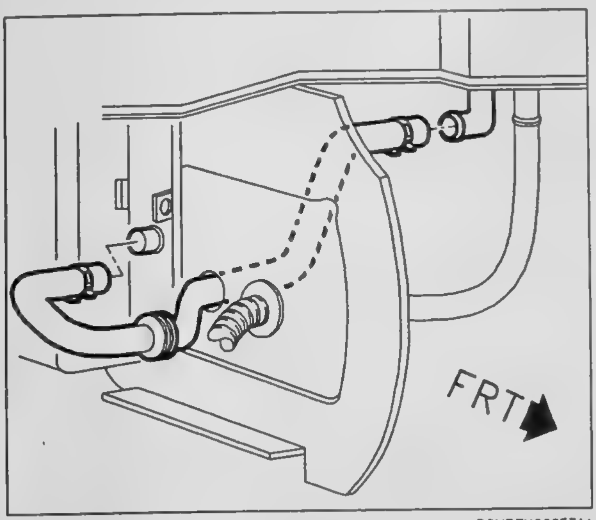
4. Remove screws from CRFM upper mounting closeout panel that retain charger receptacle cable.
5. Raise vehicle on hoist. (Refer to "Lifting and Jacking Support Points" in this manual.)



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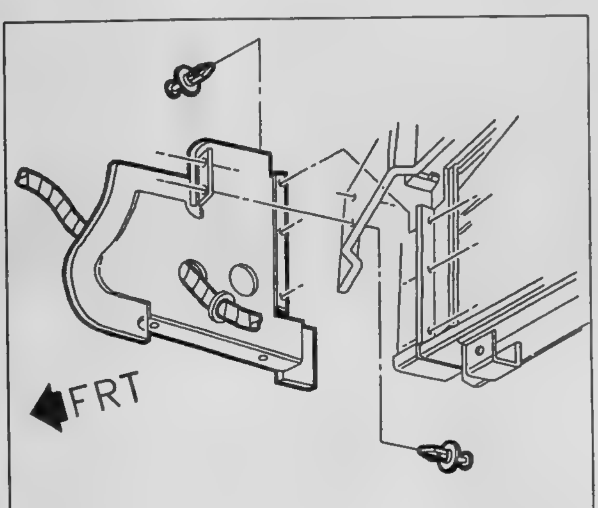
6. Drain coolant as outlined in "Main Path Coolant Draining" procedure found in this service manual.
7. Remove clamp and hose from radiator inlet from charger receptacle.

IMPORTANT: Coolant will flow from both the hose and the valve fitting.

8. Remove clamp and hose from charger receptacle outlet.
9. Remove grommet from radiator side air baffle.



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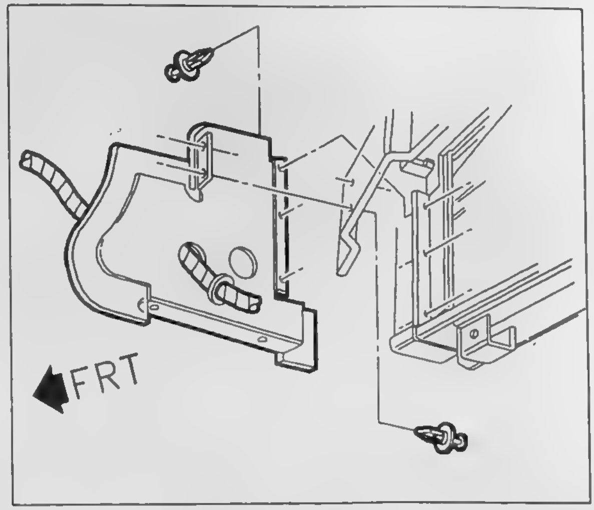
10. Remove charger receptacle cable with grommet from radiator side air baffle.
11. Remove retainers from right side air baffle. Remove baffle from vehicle.

INSTALLATION

1. Install radiator side air baffle.
2. Install charger receptacle cable with grommet through radiator side air baffle.



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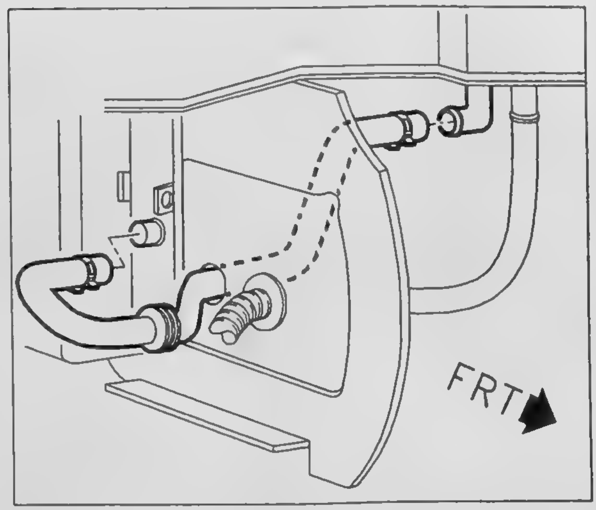
3. Install charger receptacle outlet hose and grommet through the radiator side air baffle.
4. Install hose and clamp on radiator inlet. Position clamp tangs at 6 o'clock.
5. Install hose and clamp on charger receptacle outlet. Position clamp tangs at 6 o'clock.



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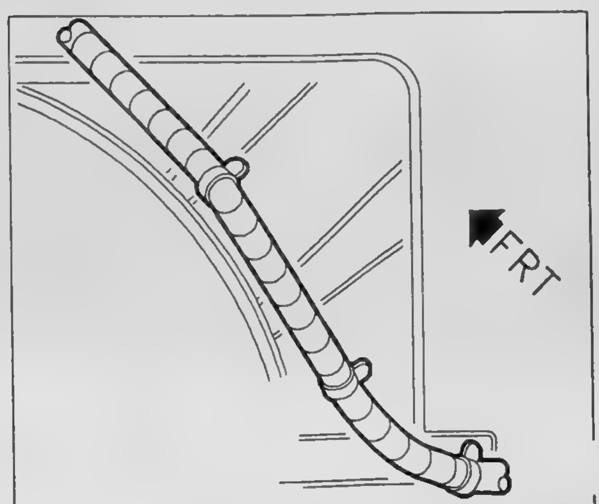
6. Route charger receptacle through front end panel. Install charger receptacle retainer on radiator shroud.



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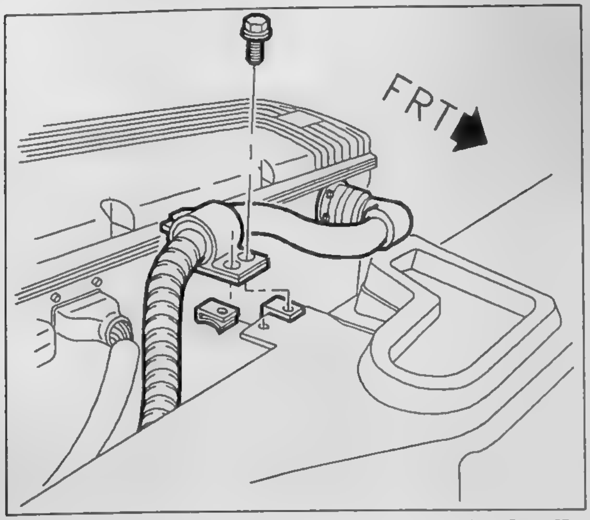

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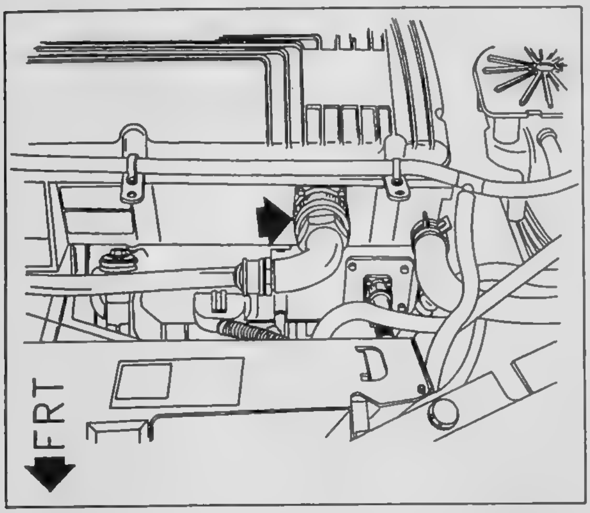
7. Install charger receptacle cable into CRFM upper mounting closeout panel cable bracket and install screws.



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8. Connect charger receptacle connection at PEB.
9. Enable high voltage. (Refer to "High Voltage Enable" in this manual.)
10. Fill coolant as outlined in "Fill Coolant System" procedure found in this service manual. Check for leaks.
11. Install underbody front air deflector assembly. (Refer to "Underbody Front Air Deflector Assembly" in this manual.)

Index

A

B

C

D

E

F

G

H

E

F

G

H

I

L

M

O

P

Service Manual Contents

Propulsion Control Module DTCs and Service Procedures

Propulsion System Thermal System DTCs and Description

Auxiliary Battery System DTCs and Description

Pedal Position Sensor DTCs and Description

[illegible]

[illegible] and Description

[illegible] System DTCs and Desc[illegible]

Drive Motor [illegible] DTCs and Desc[illegible]

[illegible]

Description

[illegible]

[illegible] Drive System DTCs and Description

Liquid Cooling Service Procedures and System Descriptions

NOTE: Refer to the Index in the back of this manual or the Table of Contents in the front of this manual for location of specific component.